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OVERHEAD EXPENSE

OVERHEAD EXPENSE

IN RELATION TO

COSTS, SALES AND PROFITS

BY

A HAMILTON CHURCH

Author of "The Proper Distribution of the Expense Burden" "Production Factors" "Manufacturing Costs and Accounts," etc

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PREFACE

The question of overhead expense has always been regarded as one presenting baffling problems and, perhaps for this reason, has been thrust into the background as far as possible, while attention has been focused on more precise methods of standardizing and recording *direct* cost

Unfortunately, direct cost tends to become a diminishing, where it is not already a minor, element in cost of production The present tendency to replace labor by costly and powerful equipment, and to transfer the skill formerly supplied by direct labor to the machine itself, implies that a larger and larger share of total cost falls into overhead In other words, cost of production is being withdrawn more and more from the easily visible class of direct expense and is being transferred to the more obscure region of overhead

As long as the older views of the nature of overhead are held, its unsatisfactory character as an element of cost must continue In the present work the principles originally developed by the author in "Proper Distribution of the Expense Burden" and "Production Factors" will be more fully expanded, and, in particular, emphasis will be laid on the fundamental idea that overhead is not a vague and indirect element of the cost *of something that has been done*, but that overhead (or rather the separate and independent services that are commonly massed under that heading) is the cost of maintaining the plant *in a condition of manufacturing preparedness* The practical deduction from this is that overhead must be the cost of manufacturing *capacity*, or, more precisely still, that it is *the definite cost of a definite amount of process capacity*

Once this viewpoint is adopted, the whole aspect of the overhead problem changes The older devices—percentages, ratios, hourly burdens—are seen to be mere mathematical expedients for getting rid of inconvenient figures on bases which have no relation to the true facts of production On the other hand, the cost of manufacturing capacity, whether of the plant as a whole

or of a single process, is capable of being costed as precisely as anything can be costed, and, once this is effected, further costing in whatever detail is required is only a matter of mechanism

When manufacturing capacity is adopted as the basis of cost, standardization is implied No apology is needed for this The principle underlying standardization is a sound one, when not misapplied, and its application is being extended on every side in all productive activities In regard to overhead, standardization forces a very thorough scrutiny of the items which are allowed to enter, and the further need for segregating these items in separate services make not only for accuracy but also for much more complete control of all overhead and indirect expenditures

While this book may be considered as containing and enlarging, though from a somewhat different angle, the field covered in the two small treatises above cited, it forms an altogether fresh study of the subject, which, as already mentioned, is becoming of increasing importance with every new application of machinery to industry

THE AUTHOR

TAUNTON, MASS
May, 1930

NOTE ON NOMENCLATURE —In the two small treatises above referred to, several new terms were introduced such as *production factor*, *production center*, *supplementary rate*, etc Some of these terms appear to have supplied a "long-felt want," as they have been borrowed widely and applied to uses not contemplated by the author and certainly having very little relation to their original significance

As these terms have thus been warped from their original meaning, the term "service factor" has everywhere in this book been substituted for "production factor" It is perhaps a more correct term, inasmuch as the idea that overhead is really the cost of sundry *services* is emphasized In place of "production center" the term "process" has been largely used, although in places it has been convenient to make use of the older term As in all cases a production center is the home of a single process, the latter term suffices for all purposes and is possibly more self-explanatory.

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CHAPTER I

OVERHEAD AND PRODUCTION

Overhead expense in manufacturing is defined usually as consisting of the so-called "fixed" charges (such as rent, interest, depreciation, insurance, taxes, etc.) plus all that large class of expenditure on labor and materials[1] which cannot be charged definitely to any given job or lot of product.

Overhead also is frequently referred to as "indirect expense," a definition that expresses very clearly the mental picture formed by many people, in which expenditure that is easily measureable and is visibly connected with particular jobs (*e.g.*, the wages of a man operating a lathe) occupies one-half of the picture, and *all other* expenditure, compressed into a jumbled mass, forms the other half.

Overhead, again, is frequently termed "burden." This term also illustrates a state of mind. The mental picture corresponding to the term would appear to represent direct labor as struggling under a heavy load of undeserved misfortune. *Burden* seems to signify something that inevitably must be paid for, but of which the value is in great degree under suspicion and its appearance as an element of cost reluctantly and grudgingly accepted. The truth is, however, that the expenditures

[1] In this and all succeeding chapters the question of "direct" material (*i.e.*, material that forms part of salable product) is excluded from the discussion, unless *specifically mentioned*. The cost of direct material does not affect the incidence of overhead on manufacturing cost. There are, in fact, certain industries that have no direct material in the costing sense, but their overhead problems are not thereby modified.

ranking as burden are every whit as essential to productive processes as direct labor itself, and their ultimate bearing on the cost of each individual job can be seen as clearly, if we go the right way about it

It is this *all other* expenditure, this *burden*, that will be the subject matter of this book

Obscurity of Connection with Processes —The most limited intelligence can picture that the wages of a man doing process work on a piece of product are, metaphorically speaking, *passing into that material hour by hour* and forming part of its cost But it is less obvious and, therefore, less easy to picture the manner in which the wages of a stoker at a boiler, the salary of a superintendent in his office, the cost of lubricating oil, the running charges for an electric tractor carrying product between processes, the wages of a man repairing a roof can be connected with the cost of that piece of product on which we observed the operator to be working It will be fairly clear, however, that if we throw all these *other* expenses into a common fund and label it "overhead" and then seek to connect it with cost by establishing a ratio between its amount and the total cost of the operators' wages, we shall have "solved" the problem only in the sense of having shelved it by a mathematical trick The resulting charge can obviously have but little real relation to the true bearing of the different classes of expense on the process being carried out on the material

Nevertheless, it must be admitted that this method of dividing all manufacturing expenditure into two main classes, the "direct" and the "indirect," has all the authority to be conferred by long-established practice The traditional and customary collection of all expenditure (except that of operators' wages) into a jumbled mass, distinguished by some term expressing its *separateness from what is regarded as true cost*, takes its origin, in fact, from the very beginnings of factory industry The Scottish term "oncost" (used as an equivalent for the term "overhead" or "indirect expense") exhibits in its structure a very definite implication that it is something that is not true cost, but merely an amount *added on* to true cost in order to get rid of it on some recognized basis

Origin of the Method —Nothing appears to be known of any published study of the cost question until 1832 In that year a small treatise entitled "Economy of Manufactures"

was published by the eminent British mathematician, Charles Babbage The principal reference to overhead is as follows "In any particular manufacture there will be a certain minimum proportion of indirect expense for supervision, lighting, clerical work, passage of materials from process to process, repairing, etc, which cannot be exceeded in any similar factory without a less efficient production resulting "

The only suggestion implying that an item of overhead should be definitely connected with process cost is the following "It is of great importance to know the precise expense of every process, *as well as of the wear and tear of machinery that is due to it* " In other words the very sensible suggestion is made that what we now term "depreciation" is a concern of process cost The suggestion appears, however, to have fallen on barren ground, and depreciation continued to be included in "all other" expenditure and thus its connection with the processes it belonged to was, of course, lost and hidden

Evasion of the Problem —Except in the case of depreciation (and even here he does not give any specific instructions as to the method of combining "wear and tear" with direct cost), Babbage failed to discern that indirect expense was a collective term for services having very different incidences on particular processes The only thing left, therefore, was to deal with such expenses in a lump sum and express them as a ratio of something The choice was obviously between a ratio based on time of processing or on wages of operators, but the former seems not to have been perceived Probably the fact that industry had not yet forgotten the premachinery stage (in which hand skill was the central feature) was responsible for the choice falling on wages

Indirect expense continued to be expressed as a percentage of direct wages for a long period without any suspicion of its possible incorrectness, and this method is probably more widespread today than any other But its adoption in the first instance was obviously a matter of accident, and it is, from a practical viewpoint, not much more than an evasion of the real issue which is, in regard to every item of expenditure we must ask For what actual service to production is this expenditure incurred? It will then be found that such services have separate and distinct incidences on each separate process

First Appearance of the Machine Rate —Nevertheless, as machines grew in size, cost and power consumption, acute

observers began to see that there was something gravely wrong with the percentage method. At a time when machinery was yet in its infancy, no great difference between machines existed, but, after the invention of the steam hammer, by James Nasmyth, the scale of mechanical adventure grew very quickly. Ship engines came to require very large machine tools, and then it probably dawned on someone that it really could not be right to charge one job done on a small lathe in one hour with exactly the same overhead as another job done on a huge planing machine in the same time.

Here, again, was a great opportunity. The idea that overhead was, in some way or other, *closely connected with individual processes* was in sight. But, again, a mathematical idea was adopted to settle the problem. The notion of "loading" particular machines suggested itself. Machine rates were set up on an arbitrary scale of relative importance, by which the cost of processes was loaded with overhead in some sort of proportion to the size, cost, power consumption, etc., of the different machines.

The device appears to have had no great vogue. The reason for its want of success was, no doubt, that it was but a half-hearted attempt at solving the overhead problem. Only a *portion* of the total overhead was distributed in this way. What was left had to be distributed by a percentage as usual. Further, the settlement of the problem was complicated by the fact that idleness of machines was not taken into account. Consequently, when shops were not busy, the nature of the resulting costs (with only a portion of the usual amount being prorated by the machine rates and a consequently greatly increased percentage) must have been confused and meaningless indeed. It is not surprising that machine rates of this kind failed to effect a lodgment in regular practice.

Overhead Charged on Time Instead of Wages.—The next modification, made somewhere about 30 years ago, was the proposal to charge overhead not by a percentage on wages but on hours instead. In a given shop the total hours worked by all operators were added together, and this total divided into the total of overhead, thus giving a rate per hour. The argument was that operators, notwithstanding their different wage rates, *enjoy the facilities of the shop in equal degree*. As between two machines of somewhat similar size, cost and power consumption, a job done by a high-priced man at one and a job done by an apprentice at

another do not absorb overhead in proportion to the relative wage rates, but more in proportion to time occupied. It was argued, therefore, that to distribute overhead by time (man-hour) is more accurate than to distribute it as a percentage on wages earned in the hour.

In point of establishing any true relation between overhead and cost of processing, this improvement entirely misses its aim. An hour's processing on a large and expensive machine with heavy power consumption gets, on this method, exactly the same overhead as one done on a small cheap machine, or even as a hand process, such as cutting out, with no machine at all. In fact, in so far as it is true that the more important machines are operated by the more highly paid men, it would provide less approximation to facts than the ordinary percentage method.

In cases, however, where pieceworkers and dayworkers are intermingled, the method is perhaps an improvement on the percentage method. By charging on an hour-rate system, the slower worker would absorb more overhead per unit turned out, which is nearer to the facts. But as already remarked, this modification still looks at the facts of production in the old way and introduces no very marked increase of accuracy, even when conditions are most favorable to its use.

Overhead as Service Foreshadowed.—Nevertheless, this proposal to equalize the incidence of overhead on the ground that each operator enjoys the facilities of the shop in equal degree, and not in proportion to the earnings he makes, is an interesting development, since there is here the germ of the idea that overhead is really a charge for service. The picture of a shop in *full working trim*, as the product or result of a *given expenditure for overhead*, must have been present to the minds of those who developed this idea. But, unfortunately, overhead was still treated as an entity, as if it were really an actual thing (as direct labor is an actual thing) and not a mere term for lumping together diverse types of expenditure. *The idea was still to get rid of overhead by plastering it on to product in a thin uniform layer,* only the basis of this plastering was modified. But overhead is not *a* service, it is a group of unconnected services, and only when the relative absorption of these services by the different processes is sought out can correct costing begin.

Overhead as Service the Key to Correct Costs.—These gradual approaches to the idea of overhead as the cost of service (and

that such service is somehow connected with process time and not with direct wages) may be extended the one necessary step further, if we consider the imaginary case of an altogether automatic machine of very costly nature taking a large amount of power and requiring large floor space in a solid building, such machine requiring only occasional charging with raw material and occasional removal of the completed product, which we may, for the sake of argument, regard as already packeted and in salable form

In the case of such a machine, direct labor will be practically nil Perhaps a couple of hours per day of the unskilled variety or, let us say, not exceeding $2 per day in all It is easy to see that this direct labor is an utterly unimportant item in the cost of this product Any system of costs that based the process cost on this item of wages or on the hours it represents would give meaningless results On the other hand, it is evident that, as it stands, the process is costing money hour after hour, and that this money is being paid out almost entirely for overhead

No clear appreciation of what the process is costing can be obtained until we cease to regard this overhead as an arithmetical figure of value in itself, and bend our efforts to discover what is behind it *as it affects this process* When we get to know what the process is costing us for power, for building space, for depreciation and interest on the investment, for delivering and removing product, for repairs and maintenance of the machine, for supervision and other items of equal interest and importance and have reduced the cost of these different services to an hourly rate, we shall find, probably, that the cost of maintaining it in a condition of preparedness for work (or in other words, the cost of the manufacturing capacity of the process) is $4 or $5 per hour or more Knowing this, and knowing the time taken by any job, costing of considerable accuracy is possible But it must be observed that this cost is based *entirely* on a proper treatment of overhead as service

Overhead an Increasing Element in Cost.—In the early days of industry machines were small and relatively inexpensive, consuming little space and power Organization also was elementary in character Management carried its experience "under its hat," and orders were conveyed verbally to a considerable extent Under these circumstances the percentage system did not give rise to very great injustice, since the process costs of all processes were very much alike There was, in all probability, a larger

range in wage rates of operators than there would have been in process rates, if such had been set up

Only as the scale of industry grew did dissatisfaction with the percentage method begin to make itself felt The *transfer of skill* to machines rendered it desirable to do the same for the skill so transferred as had been formerly done for such skill when embodied in direct labor In other words, process cost became a living problem

Operators' Wages Not Process Cost—In any statistical summary of manufactures it may be observed that overhead is increasing at a considerable rate relative to other factors This increase has nothing whatever to do with the question of operators' wages, whether they have increased or decreased per unit on the average Process cost, which is made up of overhead, is one thing, direct cost, which is made up of wages earned on a job, is another Either of these elements can increase or decrease without affecting the other Though this elementary fact is usually cloaked and hidden by the practice of establishing ratios between the items in order to "distribute" overhead, it can be demonstrated, thus

Direct wages are not in themselves process cost, since such wages are the cost of the time of the man who is operating a process but not the cost of the process itself The truth of this statement can be recognized if we consider the case of a machine process which is being operated by a man at a high rate of wages Let us persist for the moment in regarding such wages as the "process cost"

Let us suppose that by new technical invention and by the addition of some costly gear and much increased power part of the skill exercised by the operator is transferred to the machine As a result, an operator at only one-half the original wage rate is required Have we halved the process cost?

If it be claimed that we have, let us go a step further A still more important technical improvement takes place By enlarging the machine with additional devices, so that it occupies more shop space and uses yet more power, it is made wholly automatic and self-feeding, so that instead of requiring a high-priced operator as at first or a low-priced one as after the original improvement, the machine now requires no operator at all This means that there are now no more "direct" wages Is, therefore, the process costing us nothing?

In this extreme case the absurdity of such contention is self-evident. Direct wages are seen to be not only wholly different quantities from process costs but not even an absolutely essential addition to or accompaniment of process cost. If we use the Scot's term and speak of "oncost" we are now in the awkward situation that we have nothing to put the oncost *on*. In other words, we have nothing with which to establish a ratio so as to effect distribution of overhead.

It may be inferred from all this that overhead is something that is connected with the cost of running processes, or, in other words, of maintaining manufacturing capacity in a state of preparedness to produce. Process cost is, thus, something different from direct-wage cost and also something which it is imperative to ascertain for its own sake, free of all dependence on ratios or percentages on direct labor.

Conclusion.—We have now arrived at the point where the future treatment of our subject has been outlined. The elements of cost (excluding the question of direct material which does not affect overhead problems at all) consist of services to the productive process, and no expenditure that does not perform a service to production is a legitimate part of manufacturing cost. These services are usually divided into two main divisions, namely:

1. *Operative service,* which is termed "direct labor." The only difference between this and other services is that it is the only service that is in strict proportion to production, for the reason that it can be laid on and off as required. For this reason it is usually more convenient to treat it separately from other services, but not always. Sometimes operative service can be conveniently consolidated with the other services, and in such cases the item "direct labor" does not appear at all in costs.

2. *Process Services.*—The jumbled mass of expenditure usually called "overhead" really consists of expenditures on a number of entirely separate services, which correspond, as we shall see, to certain functions undertaken by the manufacturer in addition to his prime function, the conversion of materials into new forms. Some of these functions are optional, others are always present in all factories and plants. Instead of massing such items in one total of overhead, they are kept separate in their natural and proper places, with the result that the cost of each separate service to production is clearly visible at all times. The total cost of all such services for a period and the total cost of all over-

head will be the same figure, though arrived at by a different route.

This total cost of all process services is the total cost of running *all* processes at full time. This is equivalent to the statement that it is the cost of the manufacturing capacity of the plant as a whole. It can also be defined as the total cost of *maintaining all the processes of the plant in a state of preparedness for production over a given period*, say a week of 48 hr.

The cost of process services (and the same is true of the corresponding total of overhead) has no relation to but a complete independence of the operative service (*i.e.*, direct labor). The cost of the manufacturing capacity of the plant would be the same if all direct operators' wages were increased or reduced 50 per cent.

The problem to be undertaken is the connection of the process cost services with *individual processes*. If the total of service cost (which is also the total of overhead, as indicated above) is $5,000 for a year of 2,400 hr. and there are five processes, then we have a total manufacturing capacity of 5 × 2,400, or 12,000 hr. But without further investigation we cannot state the value of an individual process hour. The *average* value is, of course, about 41 cts., but to assume that this average is true for all five processes would be as bad as to trust to percentage distributions. One or more of the processes may cost 80 and others 20 cts. an hour. Our problem is to discover a method of finding the correct process rate for each of the five processes.

Further, there is an additional problem that has, so far, only been hinted at. A given expenditure on overhead is the cost of manufacturing capacity for a definite period. But suppose that some of this manufacturing capacity is not utilized for production. Suppose that some of it is, for various reasons, wasted, while the total of overhead remains the same. How shall this situation be faced? Must the waste be ignored and jobs charged with the total cost of the capacity, or shall we separate the cost of wasted from the cost of utilized capacity, so that both can be shown separately? The general outline of the solution of this last problem will be given in the next chapter.

CHAPTER II

THE PROCESS DOLLAR

From what has been said in the previous chapter it will be seen that there are only two kinds of dollar entering into cost

1 The operative or direct-wages dollar

2 The process dollar

For the first, the manufacturer gets a certain quantity of operative time, depending on the skill of the operator For the second, he gets a certain quantity of process capacity, depending on the amount and value of each service making up a process No other elements enter into cost of production When we have ascertained the number of direct-wage dollars and the number of process-cost dollars that have entered into a given job, all that can be known is known about the cost of that job

The Process Dollar —While everyone will understand the nature of the direct-wage dollar without the need for further explanation, the composition of the process dollar is the main thesis of this book In order to perceive the value and, particularly, the naturalness of this unit, all previous conceptions about overhead and its distribution by ratios or percentages on direct wages or shop hours should, as far as possible, be set aside The upbuilding of the process dollar proceeds on entirely different lines from the customary treatment of overhead It depends not so much on a careful analysis as on a simple but rigorous *keeping separate* of items of expenditure that form natural groups, but which have ordinarily been collected into one unmeaning total These natural groups are here termed "factors" and in particular "service factors," and the process dollar is made up of so many cents for this factor and so many for that, each process having its own particular and individual call on each of the factors Obviously, therefore, the composition of the process dollar will vary from process to process in correspondence with actual facts

The Process Is the Natural Cost Unit —That the process is the natural unit of costing will be recognized when it is considered, first, that all the varied expenditure comprised in overhead is

made only for the purpose of maintaining processes in a state of preparedness for work, and, second, that *only by processing can money be made*. The essence of manufacturing activity is the effecting of changes in the status of material, such changes being continued until the original raw material is changed into a salable form. This series of changes is wrought only by means of processes, whether these processes are wholly carried out by automatic machinery, or by machinery plus operators (direct wages) or by hand work alone. The moment we cease to effect changes in material, that is, the moment processes are closed down and cease to function, every source of profit necessarily ceases at the same time.

Under modern conditions, when hand skill is being transferred to machines every day, unless the emphasis is turned away from the direct-wage operator and focused on the process itself, it will be evident that we must be getting farther and farther away from cost reality with every such transfer. As processes tend to become automatic or nearly automatic, and as direct operation tends to give way to mere occasional attendance, very little argument is necessary to prove that the method of costing must follow parallel lines, if anything like true costs are to be expected.

Even where skilled operation remains an important factor, it is still true that in many cases it tends to become a *relatively* less important factor in total cost. Costly and powerful machines standing in solid modern buildings, with processes carried on by complex services, frequently represent an hourly process cost which is far greater than the hourly wage of the operator. In other words, the process dollar and not the direct-wage dollar is the most important element in the cost of work done by such processes.

Composition of the Process Dollar.—Those who are accustomed to think of overhead as adequately disposed of when it has been plastered in a uniform layer on the cost of jobs as represented either by the direct wages or the direct time concerned may be invited to consider the different conditions and the extremely varied requirements exhibited by taking a bird's-eye view of a large plant. It will quickly be realized that each process *must* make a highly individual call on the total expenditure of the business, and that no simple ratio can possibly guide such expenditure to the process incurring it.

Some of these processes will be housed in costly buildings, and others may demand little more than mere sheds. Some are carried on by small and cheap machines, others by large and expensive machines in which considerable capital is locked up. The equipment used for some processes demands frequent and careful repair, while that used for other processes is of such character as to require very little. One process may require the minimum of power, another may take 15 or 20 hp. per hour. A group of processes here can be set together in small space, another group there may require a large floor area. Some processes require a strong illumination, others very little. Here is a product requiring nothing but the merest routine precautions to manufacture, there is one which requires the services of draftsmen, expert engineers, chemists and much attention from superintendents and foremen in addition to the ordinary manufacturing routine. In some cases we find processes demanding the service of heavy conveyors or expensive overhead travelers, in other cases nothing of the kind is necessary. Again, some products are of a nature to demand an elaborate production control system, while others, perhaps alongside them, may be of such simple processing sequence as to require no such aid.

Service Absorbed Unequally by Processes.—It will be evident, from this brief glance at conditions frequently found, that we are very far from knowing much about true cost unless all the varied conditions (under which processes are conducted) have been taken into account, for it is obvious that such conditions bear *unequally* on processes. To conduct one process, greater expenditure is incurred than to conduct another alongside. Each process absorbs different kinds and values of services, and, *until a monetary value can be assigned to such services* and expressed as an hourly, weekly or monthly charge for the process, it is difficult to escape the conclusion that the hidden relations between expenditure and process cost are eluding us.

Fundamental Bases of the Two Costs.—Of operative or direct-wage service cost we need say little. Either the man is working on a job or he is not. In the former case his wages form part of the cost of the job, in the latter case he gets no wages. This is a clear-cut issue and presents no difficulty.

The fundamental difference between operative and all other services to processes is that expenditure on operation is expenditure for *actual work*. Expenditure on all other services (hitherto

comprised in the collective total of overhead) is not for actual work but for a given amount of *capacity for work*.

Work and Capacity for Work.—This distinction must be thoroughly understood. It can perhaps be explained most satisfactorily by considering what would happen if, instead of paying off an operator as soon as we had no work for the process he is conducting, we had to keep him in idleness at his usual rate of pay. The definition might be met by considering that direct operators were *engaged by the month or year and not by the hour*. In this case we should be paying his wages not necessarily for the work he had done, for he might have been idle half the time, but for his *capacity* to do work. He would be there, ready to do work, and we should pay him for that readiness, that state of preparedness. If we could not keep him busy, that would be our loss. On the other hand, the salary we paid would necessarily represent a definite maximum of capacity in the given period. If, for example, we fixed his working hours at 48 in a week, then whatever we paid him would be the price of a capacity of 48 hr. duration.

Now, most of the services which form part of process cost are on a footing very closely similar to that of a direct-operator paid by the month or year instead of by the hour. For a given expenditure, say $5,000 in a month, we maintain a certain maximum process capacity. If all that capacity is utilized, well and good. It goes automatically into cost of jobs, just as the operators' wages do. But if we fail to utilize all the capacity thus provided, that is, if some processes are idle part of the time, that would be our loss, just as it would be our loss in the case of a direct-operator on salary.

If all the cost of process service could be cut off as soon as the process was idle, then we should say that service cost was the cost of process *work*. But it cannot be so cut off. Sporadic or unintended idleness of processes is a condition that is very common but is hardly ever accompanied by any reduction of expenditure. We have to pay for the *possibility* of doing process work, therefore, whether any work is done or not. This, however, is equivalent to saying that what we are paying for is the maintenance of the process in a condition of preparedness to do work, and that this preparedness has a maximum capacity for the given expenditure. Thus, with the same process, a standard week of 48 hr. would have a different total cost of service than a standard week of 60 hr. We should be paying for different maxima in each case.

Operative or direct-wage costs are, therefore, computed on the basis of work done, men being paid by the hour. Process costs are computed on the cost of maintaining the process, that is, on the capacity of the process measured in hours, and whether work is actually done or not, this capacity has to be paid for. It will readily be understood that a totally different idea is at the base of these two computations. Until the idea was developed that *overhead is, in total, a payment for manufacturing capacity*, no progress toward the solution of process cost was possible.

Composition of Service Cost.—Since the only object for which a manufacturing plant is established is to manufacture, and since manufacture is wholly embodied in processes, it follows that only such expenditure as actually promotes process production can be admitted into the total of overhead or allowed to become part of a service factor.

But not every item that finds place in a trading account is to be considered as included in overhead. If, for example, we have had a lawsuit, and hence a bill for legal expenses, it cannot be said that this directly promotes production. We cannot increase the price of our product because of it. Whoever pays for it, the customer will not be that one. This implies that an item of the kind in question must be met out of profits and cannot legitimately be charged into costs of any sort. In the same way, donations to charities and the cost of catastrophes, such as fires and explosions, etc., must be met out of profits and are no part of costs. It may, in fact, be said that all exceptional and unforeseeable expenditures are to be excluded from overhead.

These considerations lead to a definition. Overhead or service cost is composed only of *expenditures on ordinary, normal services to production*, to the exclusion of all catastrophic and accidental expenditure which must be met out of profits and cannot be recovered from the customer by way of increased price for product.

Brief Resumé.—It may be well at this stage to pass briefly in review the various milestones we have found on our path toward the solution of the overhead problem.

First, we have seen that apart from direct labor the *process* is the natural unit on which costing should be based. Next, it has been shown that the cost of processes is, in fact, a payment for the maintenance of such processes in a condition of *prepared-*

ness for manufacture Third, that the cost of maintenance of processes is contained in what is commonly called "overhead," but that actually this overhead is itself composed of expenditures on a number of *separate services*, the cost of which should never be mingled but should be kept separate so that the incidence of each group on particular processes may be calculated Finally, when all processes have received their proper allotment of services, each process will have a certain total against it, and this total will be the actual cost of maintaining or running that process for a *definite period*, say a week of 48 hr By dividing the total cost of maintenance during the period by 48, we should have a process rate for 1 hr

In ascertaining the cost of a job, three data items are required (1) time occupied by the processing, (2) wage rate of direct operator, if there is one, (3) process rate This last item represents the cost of maintaining that particular process in a condition of preparedness to do work, for one hour, *on the basis of a given total of overhead and a given number of working hours per month or year*

Standardization Essential to Process Cost —From the two last lines in the preceding paragraph it will be inferred that costing by process rates is necessarily a method of costing by standardization Remembering that it is *capacity* that process cost is based on, it is evident that the first step must be to determine exactly how much capacity we are talking of To determine the cost of a thing we must first have a unit to which the cost may be applied In the case of the direct-wage operator the hour is a sufficient unit, because we pay by the hour If there is no more work forthcoming, payment ceases, so that each hour is charged independently But as already explained, overhead, and the services which are included in overhead, is not summarily terminable at the end of any hour It continues even though no more work is forthcoming

Under these conditions it is necessary to determine in advance the number of working hours that will be worked in any given period, say a month These are called the "standard working hours" Next, having established the number of hours capacity required, the total cost of all services (*i e*, the total of all overhead segregated into service factors) is calculated for the standard month We have thus (1) a definite quantity of capacity, and (2) a definite expenditure on services to maintain that capacity

Division of one by the other gives, of course, the cost of capacity for one hour.

Utilization and Waste of Process Capacity.—In the case of direct labor there is, theoretically at least, no wasted capacity. If we cannot use the operative capacity implied in the man's presence, he is laid off and the proffer of his capacity terminates. But in the case of a process cost, if we cannot use the capacity which is offered by the process, it has still to be paid for. In the event that such idleness is unforeseen and due to poor management (either in permitting an unexpected shortage of work or a delay in providing material, etc.), it has, in general, to be paid for *in full*. Where, however, production is deliberately curtailed, some economies can usually be effected, so that the unused capacity costs somewhat less than under conditions of full-time utilization. This aspect of the question must, however, be postponed to a later chapter.

The point to be noted at this stage is the new element thus introduced into costs. This new element, namely, cost of wasted process capacity, is not a part of the cost of jobs. It is not, in fact, a cost at all but an item of waste, pure and simple. It represents expenditure on maintaining something for which no use has been found. Process capacity can neither be laid off nor stored. If the period during which it has been maintained in full preparedness passes without utilization, its value has vanished.

The accounting for a given process during, say, a month will, therefore, show two well-marked divisions. First, there will be a list of jobs or a tally of so many yards or pounds of material that have been processed in the month. Second, there will be a list of wasted hours, during which the process was not being employed in doing work. The cost of these wasted hours must evidently be met out of profit, since the customer can hardly be expected to pay for them in an enhanced price for the goods.

Process Cost Is Standardized Cost.—It follows that not only is standardization of service factors and working hours essential but also that the resulting process cost is a standard cost, in the sense that it is always the same, if the job be done in the same time. As the influence of wasted capacity, that is, of idleness of machines and processes, is entirely removed from the cost of jobs, it will be evident that the latter will not be moving up and down according to every fluctuation in the flow of work,

as is the case where ratios and percentages are used As the cost of process capacity is the same under normal conditions whether we use it or waste it, it is obvious that *the cost of using is wholly independent of the cost of wasting* We may, in short, consider waste as a job like any other If the process is running on salable jobs, its cost discharges on those jobs, if it is running to waste, its cost discharges into the pool of waste The one does not affect the other

This is only another way of saying that the cost of process work on a job is the same at all times, until conditions so alter that new standardization is necessary

Features of the Process Dollar—The peculiar features of what has been here termed the "process dollar" may now be summarized

Unlike the direct-wage dollar,[1] the process dollar is wastable It represents the cost of process capacity and not of process work Consequently, unless that capacity is actually applied to work, its value is lost

The amount of capacity represented by the process dollar will vary from process to process In some processes we may get two hours for the dollar, in others only a few minutes This, of course, is precisely parallel to the wages dollar, which purchases several hours in some cases and possibly only one in another

In some processes the process dollar is the only element of cost This is the case when processes are so nearly automatic that they require only occasional attendance, the cost of which is incorporated in the process cost and not treated as direct wages

In general, however, job cost will be made up of two elements (1) direct-wage cost and (2) process cost In the latter will be represented all legitimate overhead incurred by the process charged to it through service factors in the manner which will be described in later chapters

Conclusion—In these two introductory chapters nothing has been said as to the manner in which service factors are segregated instead of being massed in a single jumble of overhead, nor of the way in which the share of individual processes in

[1] The direct-wage dollar is non-wastable only in theory In practice a great deal of wasted direct labor may usually be found in spite of ingenious methods and devices for its prevention Theoretically, however, if a wage-earner is not working on product he is laid off

such factor services is calculated These matters will now be entered on, but, as a preliminary and as a gradual simple introduction to a somewhat complicated subject, a very elementary case will be taken, belonging actually to an earlier period of manufacturing development but on that account offering a clearer demonstration of the underlying *principles* of costing by processes than could be obtained by taking up at once conditions as found in large modern plants

CHAPTER III

OVERHEAD AS SERVICE

I. ELEMENTARY FORM

Much of the obscurity surrounding the subject of overhead has arisen from the fact that, in practically all cases, a manufacturer does other things than manufacture. That is, of the total activity of a plant only a part, and sometimes a relatively small part, is concerned in effecting changes in the condition or status of material, which alone constitutes actual production or manufacture. The manufacturer fulfils other functions, and though those functions are undertaken by him only with a view to his main object, *viz.*, manufacture, they are in their nature clear and distinct from actual production.

Actual Production the Last Link in a Chain.—It will be the object of this chapter to demonstrate the position above outlined, and this also may be put in another way, namely, if we regard with an analytical eye the various activities (and their connected expenditures) in and about a manufacturing plant, we shall realize not only that but a portion of them have to do with actual transformation of material into new forms, but also that such actual production is the last organization in a chain of separate organizations, or a last link in a chain of separate links. And with the exception of this last link, all the chain is made up of *services* to actual production, which services (or, rather, the cost of them) are usually grouped under the term "overhead."

Studying the Elements of Production.—Those who have had the opportunity to observe manufacturing industry in its more primitive forms, as carried on not long ago in some parts of Europe, will be able to recognize at once the difference between the main function of the manufacturer, namely, conversion of material into new forms, and his subordinate but still very distinct functions that precede his production function. In a large modern plant these functions are not so easy to recognize without some study and analysis, but in the progress upward from

the most primitive forms of industry to the modern scale, it can easily be seen how one after another of these functions (or services) is assumed and incorporated with the direct productive function, as the scale of operations increases.

Most Primitive Form. No Overhead at All.—In the Middle Ages when a man wished to build a house, he accumulated a stock of all the materials necessary and also all the primitive tackle then in use, such as scaffolds, ladders, cranes, etc., until he had assembled all the elements except direct labor. The craftsman then entered on the scene and contracted to make use of the material so as to erect the building desired. If we regard the craftsman in this case as the technical and skilled element, the productive force in essence, then it is apparent that his operations were carried out without any question of overhead. He was at no expense. He had to provide nothing, except labor and skill, and for this he was paid at an agreed price without deductions. In the same way, other trades were exercised. The customer provided cloth and thread, the tailor came to the house and made the garment. In all such cases production was carried on *without the producer having to pay anything out*, from the full price received, for any kind of service to assist his efforts. In other words, he had no overhead.

Second Stage. Overhead at a Minimum.—It would be tedious to trace the progress of manufacturing or production through its various stages, but we may jump at once to comparatively modern times and exhibit the case of manufacturing producers whose operations were carried on with some, but not all, of the different varieties of overhead now found necessary.

In certain European cities 20 or 30 years ago, there might be found considerable numbers of craftsmen who, though carrying on their operations necessarily on a very small scale, were, in every sense of the word, independent manufacturers. These men had their own independent little shops, they contracted for the sale of their output, they determined their own working hours, and, out of the price received for their output, they had to pay certain sums for services enjoyed by virtue of which they were enabled to carry on their business. Such men were sometimes known by the name of "little masters," a title exactly descriptive, for these men were, in essence, capitalist manufacturers on a tiny scale, and some of them were also employers of labor on a similar scale.

Under these simple conditions, it is evident that the question of overhead can be studied in its most elementary form, and, in fact, it was a contemplation of just such production on a very small scale that first led the author to formulate the systematic treatment of overhead as service, the outline which was first published in book form, under the title "The Proper Distribution of the Expense Burden," in 1910.

Survey of Conditions in the Little Shops.—While not true in all cases, it frequently happened that such elementary industries were located in a building of, say, three stories, containing possibly six to eight little shops on each story. The two lower floors might be provided with a common shafting driven by a small steam engine, while the topmost floor was occupied by industries not requiring power.

We may assume that each of these little shops was rented to a mechanic occupied on some minor line of manufacture, one of which comes to the author's recollection as the production of pepper-castor tops, *i.e.*, the perforated metal caps of pepper castors, which might be elaborately embossed and ornamented and executed in silver or less valuable material. The industries not requiring power were frequently those employing flypresses for stamping, bending and perforating metal blanks, buttons, etc. In this case the little master was generally a skilled press-tool maker, and sometimes employed from one to half-a-dozen girls as operators of the flypresses.

Here, then, were a number of independent industrial plants, each busily at work on product, and each carrying on manufacturing operations *by the aid of certain services* which had, of course, to be paid for out of the profit made. Except as regards the scale, most of the important elements of industry as presented in a modern plant were here present. These elements we shall now proceed to consider in detail.

Services Enjoyed by the Little Shops.—The aspect of the matter that interests us is comprised in the question: What overhead was incurred by these small industries, and of what does it consist? If it is possible to discover *exactly* what is represented by overhead in these elementary cases, it is evident that great progress will have been made in understanding the bearing of overhead on production when the scale of operations is greatly magnified.

1 *Rent The Space Factor*.—The first item of overhead (and one that would be incurred by *all* the little shops) is that of rent. Obviously, this rent is not the same for all. It will depend in the first place on the space occupied by the shop. A shop occupying one-quarter of a floor would necessarily cost more than one occupying only one-sixth. The ground-floor rents would be higher than those of upper floors, because they represent greater facilities in handling goods, loading and unloading, etc. (It must be understood that no elevators or crane facilities were provided. The first were but little known anywhere and the small size of the products made the second unnecessary.) Nevertheless, the ground floor may be regarded as more valuable by reason of possessing what *was equivalent to* an elevator service, as compared to the upper floors.

This element of rent enters at once into the little master calculation of the cost of his product. For each kind of work of this class, there would be a limit beyond which the producer could not afford to pay more rent. Moreover, the choice of premises is dictated by reasons. If it should happen that product is packed in large cases or material received in such form, then the extra rent payable for a ground-floor shop would be justified, since the expense and trouble of handling on stairways would be avoided. Again, if the producer were working alone, he would require but a small space, if with employees, a larger space at an increased rent. Or if the machinery employed were bulky, as for instance a long, slowly moving belt passing through a drying box, this again would involve a larger space and higher rent.

In all these cases it is to be observed that rent is payable *in proportion to service enjoyed*. A manufacturing process which requires small space, and that on an upper floor, will incur less overhead for rent than one which takes up more room or requires the additional facility of easy handling on the ground floor.

Rent is thus one item of overhead, but it is in these simple cases a clearly defined, *separate* and altogether homogeneous charge against production. Its incidence on the cost of product is easily calculated, and any increase or decrease in it is at once felt in higher or lower costs.

We are able, in this instance, to ascertain the incidence of rent (which, as it will be seen later, is equivalent to the space factor in large plants) entirely separate from that of any other service or item of overhead. As between the different shops

there will be different space-factor charges according to the service enjoyed The question then arises To what end or for what advantage should we cease to consider rent as a separate charge and, on the contrary, throw it into a common account with other charges, labeling the whole "overhead?" It will be seen later that so far from deriving advantage from such a procedure, we are giving up very important opportunities of obtaining information

The question of what rent is composed and of how it is built up, so that a certain space is assigned a particular amount of rent and no other amount, is a matter which has nothing to do with the small manufacturer under the conditions just described —all *he* has to do is to pay it—but it has immense importance in regard to the assignment of space factors in modern plants and will be considered at length in a later chapter

2 *The Power Factor*—Here we enter the field of a service that is, obviously, entirely different from that represented by rent and has nothing to do with it In the cases above cited, power was supplied by a common shafting running through all the shops on a floor The charge for such power was roughly according to the amount of machinery used by each little master In those days the fractional horsepower motor had not come into common use, and power was generated on the premises by the landlord

We may, however, assume for the moment that, as would be the case today, each of the shops was served by its own independent motor with current taken from the mains Under these conditions it is obvious that the payment for power made by each producer would be in strict proportion to the use made of it The shop that required no power would have no power factor One that drove a small winding or polishing machine would have a very small one One that possessed a heavy power press or a series of machines would have the largest one

All this needs no argument But it should be noted that we now have the overhead expense for each of the little shops in two entirely independent items, namely, space factor and power factor, which are clearly not in any way related, and *either of which may be increased or diminished without affecting the other* If we regard the work done in each of the shops as a single process, it is evident that each such process has a space factor and a power factor which can be stated with absolute accuracy

Again we may ask What end is served by throwing these two independent factors into one total and calling it "overhead?"

3 *The Machinery Factor* —Having now ascertained that the overhead so far incurred by our little producers is really made up of two perfectly distinct items, rent and power, we may proceed to consider what other items can be discovered The most obvious expense remaining will be the cost of the machinery and equipment possessed by each little shop

For the moment we will assume that instead of owning his equipment each such producer rents it This is no very far-fetched idea, since today machines are rented in some of the most important industries Each producer, then, at the month-end will receive a bill representing rent for the use of the press, winder, stove or other kind of equipment he makes use of It is easy to see that this charge has nothing to do with the rent he pays or the power he consumes, but is a service factor of quite another class It is, therefore, interesting to inquire just what such a charge, which we may term the "machinery factor," represents

For the purpose of the argument we may assume that the terms of rental comprise the maintenance of the machine in full working order, *i e*, that the charge includes repairs on the equipment when necessary, its periodical inspection and overhaul, and, in fact, everything that contributes to its running efficiency

The charge made to the producer will cover (1) interest on the capital value, (2) depreciation, (3) a sum calculated to cover the cost of repairing and overhauling, (4) insurance [1] In addition to these charges, which represent out-of-pocket expenditure by the owner of the machine, there will be (5) an additional sum representing owner's profit, which will be large or small according as the owner has a monopoly or not Patented machines will command a larger profit, machines bought in the market and merely rented as a commercial transaction will be charged at a minimum profit, for reasons of competition Whether or not the owner of the machine makes a profit does not, however, interest us Attention should be fixed on items 1 to 4 out of which the machine rental, except profit, is built up

[1] Items like insurance and taxes (which are related to capital values in a manner similar to interest and depreciation) will be omitted from this study of small scale production for the sake of simplicity

These four items represent the *current cost* of processing equipment They are the charges which must be met by the owner of the machine whether he makes any profit on renting it out or not Unless he meets these charges by sufficient rent, he is losing money If he only just meets them, then he is making neither profit nor loss on the transaction Neither more nor less than the sum so fixed will exactly represent the cost of providing such equipment in running order

Although the little-shop producer pays a sum additional to these four items by way of owner's profit, that does not affect the argument The rent charged to him for the use of the equipment in running order is a sum that must be added to his costs And this addition represents a third factor—a machinery factor, which is, obviously, entirely independent of the amount he pays for rent or that he incurs for power If he substituted a machine at less rental charge, his *power cost* would not be lessened unless the new machine took less power Similarly, his *rent* for the shop would not be diminished, unless by adopting the new machine he required less space and could therefore take a smaller shop

Thus far, overhead is seen to be made up of three entirely separate and independent factors—a space factor, a power factor, and, as just discussed, a machinery or equipment factor This latter will, in general, be termed the *process equipment factor* when we come to discuss operations on a larger scale It is thus particularized to distinguish the factor of *processing* or *productive* equipment, such as a lathe, vat, loom press, etc , from that of other equipment, such as a conveyor, a line of shafting, a ventilating fan, etc

If, as before, we regard the work carried on in each of the little shops as a separate process, then the overhead charge against such process is made up of space factor, power factor and machinery factor, *each of which can be increased or diminished without altering the others*

4 *The Storage Factor* —In the case of our little shops this factor is commonly non-existent under ordinary conditions But cases may be imagined in which such a factor would exist If, for example, one of the shops were engaged in the manufacture of a product which was, for some reason or another, not commercially profitable, and if under these circumstances another product were to be taken up of a very bulky nature, it is highly

probable that the space already in use would prove inadequate for the handling and storage of such product, even though the machinery used occupied the same space as before

If this difficulty were to be met by hiring another room for the storage of the new bulky raw material, it is easy to see that this new charge is of a quite different nature to the rent paid for the shop containing the processing machines While that is unaltered, an additional amount now comes into cost How must this new item be regarded?

It is, of course, a space factor, but a new kind of space factor, inasmuch as it does not contribute directly to processing but has been brought about by a change in the nature of the product itself It is entirely independent of the space factor that serves processing directly, since it has come into existence after that and might equally well go out of existence without affecting it, if the product were changed again

If then our little producer takes this new amount into his cost as a separate item, under the term *storage factor*, its exact incidence on the total cost of product will be clearly visible He will now have four elements of his cost (1) his space factor representing cost of processing space, (2) his power factor, (3) his machinery or equipment factor, representing the amount paid out for having and maintaining his processing machinery in a state of preparedness, (4) his storage factor, representing the cost of providing special room for a bulky product

If he desires at any time to calculate the cost of some new product, he can easily and readily determine it, either with or without storage factor charge, because all the items of service incurred by him have been ascertained and kept separate If he had, from the beginning, jumbled all his outgoings into one common fund called "overhead," all that would be visible when any changes occurred is the simple fact that the relation of overhead to total hours worked had risen or fallen And this information would not be of great value

5 *The Transport Factor* —In the foregoing we have assumed that no mechanical facilities for handling product were either necessary or in existence But it was pointed out that virtually ground-floor premises did provide such facilities as compared with upper floors, and that rents would be higher for just this reason

Of course, in the actual case of a little producer, no attempt would be made to deal with the space factor in such a manner

that the amount actually due to the rent paid for processing space was separated from the amount due to facilities for handling and transporting materials. But theoretically, at least, it would be possible to make such a distinction. Practically, it would be the difference between the rent charged on the ground floor to that charged on the floor above for precisely similar space. If one such space were $100 and the other $80, then the difference, $20, would naturally represent the charge for handling and transport facilities. Processing space factor would thus be $80 and transport factor $20.

If our producer were offered a year contract on the basis that all materials were delivered to him and taken from him by the customers' own men, it might be a question whether it would not be worth his while to remove to the second floor. By so doing his transport factor would vanish, and the amount of this saving would be known in advance, *viz.*, $20 per month.

Naturally, in the simple conditions herein pictured, he would require no accounts to tell him this, but the thing to observe is that, if so minded, he could have his cost in such form that changes in conditions immediately affect *not a vague total sum known as overhead but separate and distinct factors, in which the effect is confined to the class of charge involved.* A one-man shop may not require figures for this purpose, but a ten-man shop is likely to need them, a hundred-man shop is likely to go wrong without them, and a thousand-man shop cannot be conducted at all without very close figuring on the result of its operations.

Other Service Factors.—In a large plant there are, naturally, other factors to be taken into account that do not exist in even a rudimentary form in a one-man shop. But the important point it has been sought to bring out in this chapter is that each of these little shops is very much the same thing as a single process in a large plant. In the large plant there will be *additional* factors, but those just described will be among them. Every process has its space factor, its power factor and its individual factor. Storage and transport factors will also be present, and, just as in the case of the little shops, these will vary in importance precisely as the nature of one product in one plant differs from the product in another plant. It is just as easy and almost as simple to ascertain the cost of factors for separate processes in a large plant as it has been to ascertain the elements of process cost in each of the little shops above described.

Little Shops Consolidated.—The argument could have been carried further. The relation of working hours to factors could have been demonstrated. The question of those shops in which the producer was also a small employer of labor could have been analyzed. These extensions are, however, unnecessary, as in following chapters we shall consider such extensions in another way. We shall now assume that a building like that described, with all its independent little producers and their processing equipment and its separate power plant, is brought under *one financial control*. In other words, the same set of elements will be pictured but with the building owned by one firm, which also has acquired the power plant, all the processing equipment, has thrown down the dividing partitions, so making each floor into one large shop, and has engaged the different producers as operators at weekly wages. In short, the little shops will have been consolidated into a regular factory, *each former shop becoming a production center for one process*, and each little master converted into the operator of the process to which he was accustomed. It will then be seen how far the independent costing of processes can still be maintained, having in view the new kinds of expenditure that will now have to be taken into account.

CHAPTER IV

OVERHEAD AS SERVICE

II *UNDER FACTORY CONDITIONS*

Before proceeding to discuss the service aspect of overhead as affected by the consolidation of the little shops which were exhibited as separate undertakings in the last chapter, it will be well to discuss one point of great importance, namely, that there is no possible escape from the validity of the factors as there outlined. It is not a question of opinion or admission of a doubtful point. The rent factor, the power factor, the individual machine factor, and, under the circumstances and conditions assumed, the stores and (more arbitrarily) the transport factors are no imaginary quantities depending on an artificial classification or analysis.

Inevitableness of Service Factors as Outlined.—On the contrary, these different classes of charge are different *ab initio* in their very nature. They are wholly independent. They have no relations one with another. Any one of them may increase or decrease without altering the amount of the others. Each of them is a distinct charge against production, that is, against the particular process being carried on in the little shop selected for consideration, because each of them is a charge for an altogether different kind of service.

The bearing of each such factor *on the cost of production* can be separately ascertained. Thus, for example, suppose that one of our small producers had taken out the cost of his product, factor by factor, and had found that his rent factor amounted to 10 cts. on each unit of product. Next, let us suppose that it became a question with him of removing to other premises at a different rent. He would easily be able to ascertain exactly what increase or decrease per unit of his product this change would bring about. It might, for instance, increase his rent factor to 12 cts. per unit of product.

Now, as he would know how much profit he received per unit of product after paying for all his service factors, it would be

easy for him to calculate just what bearing on his actual profit per unit of product this change would have It might be that the increase of 2 cts was more than he cared to have his unit profit diminished, and would, therefore, decide to stay where he was

It is no argument against this to say that under the simple conditions herein described the little producer could almost figure out such a result in his head, without any factors or cost accounts at all It is true that he possibly could, but that is not the important point The value of the arrangements in question lies in the fact that the result can be ascertained with exact precision on *a definite basis*, and that this basis is, as we shall see later, equally applicable to those conditions in which results *cannot* be figured in anyone's head, which is naturally the case in every manufacturing plant except the very smallest

Composition of Cost in the Little Shops —Before leaving the question of the little shops as separate businesses, it may be well to observe in what final form the costs would appear They would consist of the service factors themselves together with the producer's own wages (which he would naturally reckon at the rate he could obtain for his labor as an employee), plus direct material Thus

a Rent of shop (space factor)
b Bill for power (power factor)
c Bill for hired equipment (individual equipment factor)
d Rent of storage room (stores factor)
e Excess rent for ground floor (transport factor)
f Own wages

Direct Material Ignored —Direct material may be left out of account in all these discussions as it does not affect the results in any way In fact, it is not essential that there should be *any* direct material in the costing sense The work done may be merely processing on material supplied by the purchaser of the manufactured product This was actually the case in a certain number of instances in the small industries described in the last chapter, and it will simplify matters to consider it the fact in all the instances here discussed It must be noted that the fact that the material was the property of the customer does not obviate the necessity of a storage factor In many industries, particularly the textile finishing, enormous storage facilities have

to be provided by the manufacturer, although all the material he works on is the property of his customers

Cost, Profit and Selling Price —Translating the terms used above into ordinary language, items *a* to *e* would be considered as the little producer's overhead, if thrown into one total Item *f* would be direct wages If all the items *a* to *f* are thrown together, we have total cost of production Next we have to consider "production of what?"

The costs thus assembled would, of course, be those of a period, say a week, of 50 hr Now, if the producer knows how many units of his product he normally turns out in 50 hr, then the cost of production per unit is also known To this he would add a sum representing

g Profit per unit of product

Adding this item to the former items, a new total would be forthcoming, namely,

h Selling price per unit of product

It will be seen that all of these costs are perfectly usual and normal in form, only instead of having an unanalyzable total called "overhead," we have no such item, overhead disappears and is replaced by certain costs of services herein termed "service factors"

Costs of the Little Shops Are Processing Costs —While it is true that such service factors would be of the smallest possible use to the producer under the elementary conditions described, it must be remembered that we have here a very good representation of a number of dissimilar processes running side by side in a modern plant If it is possible for the individual small producer to find the exact cost of his single process, it should be equally possible for the large-scale manufacturer to find the exact cost of each of fifty processes carried on in the same plant

Why the Little Shops Can Ascertain Process Cost —The solution of the latter problem will, however, be entirely missed if we fail to observe *why* it is that the small producer can obtain his costs entirely free from the fact that other producers are working alongside him *It is because he is separately billed for each of the services he enjoys* In his case it is necessarily so He could not pay for the space occupied unless a bill for rent were presented to him He would not hire a storage room without

knowing what it would cost him He would not expect to pay for power except at an agreed rate In short, every service he enjoys has its price, and as each service is billed to him at its own separate and individual price, the service factors entering into his operations are *ready made to his hand* He does not have to calculate them They come to him All he has to do is to enter them on his cost accounts as separate items He thus has the clearest picture of the various elements that make up his cost, and the influence of each on such cost

But when we regard a regular factory, all this clearness of picture vanishes Costs of different processing operations running alongside one another are not known All that is commonly known is that a certain process is operated by a man at a rate of, say, 50 cts an hour, and that the overhead "percentage" is today 95 per cent of such direct wages, last week was 83 per cent and next month may be anything from 80 to 120 per cent

This is no exaggerated picture, but one of common occurrence Processing costs, apart from direct labor, are not known with any accuracy at all In passing from the elementary stage of operations to factory conditions, it is evident that a treatment of costs has been made that is anything but an improvement This statement is perfectly true, although costs such as those described for the little shops have never been put on paper They *could* have been so put, as will be evident from what has been said The only reason they were not is that the figures were so few and simple that they were self-evident But as soon as we come to deal with an assemblage of processes in one plant, the facts are no longer self-evident for each process Accounting methods become essential

Processing Rates in the Little Shops —On the basis of certain figures which will be given in detail later, the costs per hour of the processes in the twenty shops have been calculated It may be of interest to present them at this stage, as it will serve to press home the point that such processing costs are highly individual to each shop (Fig 1) The *average* for all the shops works out at about 38½ cts per hour It will be seen that such an average applied to the output of all the little shops alike would produce some very extraordinary costs, if substituted for the true individual costs But not perhaps more extraordinary than those obtained every day by executives who are perfectly sure that their cost methods are fully adequate to their conditions

Top		Middle		Ground	
Shop	Per hour, cents	Shop	Per hour, cents	Shop	Per hour, cents
1	15	9	36	15	62
2	10	10	30	16	64
3	15	11	58	17	42
4	20	12	33	18	44
5*		13	45	19	43
6*		14	36	20	95
7	23				
8	24				

* Used for storage only

FIG 1 —Processing costs of independent shops

Consolidation of Little Shops into a Factory —We shall now assume that a corporation is organized which sweeps all the little producers in one building into a single organization The steps taken under these circumstances will be

1 Ownership of the building is acquired
2 Ownership of the small power plant is also acquired
3 The machinery hitherto rented by the individual producers is taken over (purchased outright) by the new corporation
4 Each of the little producers enters the service of the corporation at weekly wages
5 A manager of the whole is appointed, with a clerk and an office in the building
6 A head foreman or superintendent is appointed to supervise production in the shops
7 A man is engaged to undertake transport of raw material and finished product, packing and unpacking, etc
8 The partitions on the various floors are taken down, thus making each floor a single shop with from five to eight processes on it

General Effect of Consolidation —The general effect of this change will be that, instead of having a number of independent little producers, we now have a factory of three floors with a small power plant adjoining, some eighteen processes and a corresponding number of operators at weekly wages (If these operators were paid by piece or on a bonus system it would be of no importance to the discussion, but for the present it is simpler to regard them as day workers)

We have also additional items A manager[1] who attends to purchasing, selling and general business, a clerk, part of whose time is devoted to costs, a superintendent whose attention is given entirely to the shops and the processes, a transport man

This state of things is, of course, simply that of an ordinary small manufacturing plant, differing in no particular from hundreds of such plants at the present day Only the fact that it has been derived from, or consists of, an amalgamation of small independent businesses, each representing a single process *and each of which knew its own process costs*, makes this example interesting at this stage

Costs under the Consolidation Regime—In acquiring the property we may assume that the price paid for the building and the machinery was such that the following relations exist between the charges to cost under the old and new conditions

1 The building stood on the books of the owners at $43,000 and has been acquired, as a going concern, for the increased price of $50,000

2 The power plant, comprising building, engine, boiler, shafting and belting, stood at $3,000 and was transferred at this price to the new organization

3 The machinery stood at $14,500 on the books of the original lessors and was transferred to the new company at the same price

The new organization thus stands to meet a slightly higher interest and depreciation on the value of the building, but the same interest and depreciation on the value of the power plant and the production machinery In all three cases the item of profit to the original owners drops out of sight

New items of cost not incurred by the little shops will be salaries of manager, superintendent, clerk and transport man, also minor items for stationery and postage

Operators' wages are reckoned as $35 per week in all cases The uniformity of wage rate is assumed in order to hold that item constant in all the figuring More striking differences in process cost plus direct wages could, no doubt, be shown by assuming [illegible] or rate [illegible] but with this item held constant it will be more readily recognized that such differences as exist have nothing to do with direct wages

[1] [illegible]

Uncharged Service in Little Shops.—The addition of salaries to the costs may seem greatly to increase them, and it may be asked how it becomes necessary to appoint such officials when the original little shops managed to do very well without them.

Apart from the fact that organization of any kind gives rise to new forms of expense, the increased expenditure in this case is due rather to the emerging into light of items which existed before but were unseen than to any extravagant charge for organization.

In the case of the little producers, there is no doubt that they would spend a certain amount of their time in seeking new business, in buying supplies, in unpacking and arranging them, in packing finished product and in cleaning up the shop and equipment. But this is assumed to take place outside the regular 50 hr. per week which is devoted to *production*.

As long as the profits of each little business belong to the actual producer, expenditures like these cost nothing but time, and, *as long as that time is not taken from production*, it costs him nothing out of pocket. This, however, is only equivalent to saying that they are paid for out of the profits he earns in his capacity of producer. If it should happen that he had to take time off, so that he worked only 45 instead of 50 hr., then they would begin to cost him real money.

But when the profits belong to the concern, then it is obvious that the concern must provide these additional services, *viz.*, purchasing, selling transportation and office duties. They will then be a first charge on profits, because, as a matter of fact, profits are not reckoned until these items (in the form of overhead) have been added to costs. The operator then remains an operator and nothing else, and the other duties are undertaken by specialists. The net result should mean greater efficiency and smoothness of working, but whether this is realized or not depends upon successful management.

The place of the superintendent is also explicable on somewhat similar ground. The individual operators are no less competent than before, and we may even assume that they will be equally willing to put forward their best efforts. It is not so much in the capacity of "boss" that the superintendent will be required as a coordinator of efforts. Instructions now proceed from one source, namely, the manager who gets the business, and these instructions need to be in such form and so subdivided that each operator knows what he has to do.

This coordination, taking the shape of individual processing orders, is supplied by the post or function of superintendence This assistance to production is, of course, assumed to pay for itself It is obviously a part of cost, though nothing exactly corresponding was in existence under the regime of the little shops Each producer then received his instructions from his own customer instead of receiving them from a superintendent The superintendent's salary represents the unreckoned cost of time spent in getting these instructions

Net Result as Regards Overhead —When the figures comparing the costs of the two regimes are compared, as they will be later, it will be found that an increased overhead of moderate amount, about 13 per cent of the original sum paid out by the little producers, will now be chargeable This increase may, meanwhile, be kept in mind when the cost statements representing the consolidated concern are being considered

Overhead and Costs under the Consolidation —After the new business had been running for a month, a cost statement would, no doubt, be made out Assuming that the ordinary methods of making up cost were in use, then the statement in question would take something of the form shown in Fig 2

This cost statement discloses direct wages $2,520 and overhead $1,757 The direct wages are due to the 18 operators who are assumed to have worked full time, *viz* , 200 hr in the month, each operator being paid at the same rate, *viz* , $35 per week

It is now possible, with the figures on this statement available, to take out costs on either of the two ordinary methods, that is, either on the hourly burden plan or by a percentage on wages Figure 3 exhibits the result of the former and Fig 4 the latter

Processing Costs —The cost of performing any one of the twenty different processes assumed to be in use will, under the foregoing arrangements, be calculated as follows

$$\left.\begin{array}{l}\text{Direct wages for 1 hr}\\ \text{Add, overhead } 48\tfrac{3}{4}\text{ cts}\end{array}\right\}\text{Cost of process, 1 hr}$$

Or, alternatively, it may be reckoned as

$$\left.\begin{array}{l}\text{Direct wages for 1 hr}\\ \text{Add, overhead 69 7 per cent}\end{array}\right\}\text{Cost of process, 1 hr}$$

Either of these processing costs would be accepted as correct in thousands of plants at the present time, and we may now proceed to examine what happens when they are applied to

Statement of Direct Wages and Overhead

Month	19—	Expense	Direct
Interest & Depreciation			
Building	$5 500 per ann		
Power plant	480 " "		
Machinery	2 077 " "		
	$8,057 " "		
One-twelfth		$ 671.48	
Wages & Salaries			
Manager	$240		
Clerk	80	320.00	
Superintendent		220.00	
Power man		120.00	
Transport man		100.00	
18 operators @ $35 week			$2,520.00
Sundry Expense			
Repairs to roof		30.00	
" " mach 8		15.00	
" " " 11		10.00	
" " power plant		12.00	
Fuel and oil		145.00	
Repairs to stairway		20.00	
Cleaning		40.00	
Repairs to mach 20		18.00	
Stationery and phone		14.00	
Repairs to mach 16		22.00	
Total Expense		$1,757.48	
Total Overhead			$2 520.00

FIG 2.—Statement for the new organization Consolidated shops

Overhead prorated on wages	
Expense, as Fig 2	$1,757
Direct wages	$2 520
Percentage	69.7

Overhead prorated on hours	
Expense, as Fig 2	$1,757
Productive hours	3,600
Hourly burden	48¾ cts

NOTE.—These figures refer to the new organization

FIG 3.—Overhead percentage FIG 4.—Overhead hourly burden

estimating on a job, for the purpose of making a price to the customer

Processing Costs on an Estimate—It will be assumed that a certain job is being quoted on, the processing time on which has been estimated by the superintendent to be as follows

Process No	10	11	15	20
Hours	30	150	45	200

making a total of 425 hr in all The cost of this job will now be calculated on both plans

1 *On the Hourly Burden Plan*—In this case direct wages at 70 cts per hour are calculated for each process, and then an hourly burden of 48¾ cts per hour is added The results are presented in Fig 5

Process	Est hours	Wages		Overhead		Total
		Rate, cents	Amount	Rate, cts per hr	Amount	
10	30	70	$ 21 00	48¾	$ 14 62	$ 35 62
11	150	"	105 00		73 12	178 12
15	45	"	31 50		21 93	53 43
20	200	"	140 00		97 50	237 50
Total	425		$297 50		$207 17	$504 67

FIG 5—Job estimate on hourly burden basis

2 *On the Percentage Plan*—Here direct wages on each process are calculated, as before, but, in place of an hourly burden, 69 7 per cent on the amount of the direct wages is added, as exhibited in Fig 6

Process	Est hours	Wages		Overhead		Total
		Rate, cents	Amount	Rate, % on wages	Amount	
10	30	70	$ 21 00	69 7	$ 14 63	$ 35 63
11	150	"	105 00		73 18	178 18
15	45	"	31 50		21 95	53 45
20	200	"	140 00		97 58	237 58
Total	425		$297 50		$207 34	$504 84

FIG 6—Job estimate on percentage basis

The Two Results Compared —It will be obvious at a glance that the results are identical on each of these plans Such fractional difference as appears, amounting to a few cents only, is due to the fact that the percentages have been worked out to only one place of decimals Had they been worked out to two or more places, the results would agree to a cent

There is little doubt that in most cases such results would be accepted as very satisfactory evidence of the accuracy of the costs The two results seem to confirm and check each other in a remarkable way, although the basis of calculation is different in each But as a matter of fact, we have here rather a coincidence than a proof or confirmation, and the matter is so important that it will be worthwhile to examine it more closely

Why the Two Results Coincide —While it is true that for the particular conditions as set out in the construction of this problem the two sets of figures do coincide, it is also true that this coincidence is purely accidental, depending on one circumstance, and this circumstance would not, as a matter of fact, be likely to turn up in actual practice

The two sets of figures agree because it was assumed that all operators *were paid at the same rate* Consequently, if a given amount of overhead is to be prorated, it is evidently a matter of indifference whether we prorate it on hours or, alternatively, on wages, because, in this particular instance *only*, wages are themselves exactly proportional to hours The rate of all wages being the same, the same amount is attached to any given hour, on whatever process it was earned or by whichever man it was earned Therefore whether we prorate overhead on hours or on wages, themselves directly proportional and evenly proportional to hours, the result must be identical

Hourly Burden and the Average Wage Rate —An hourly burden rate will always coincide with *one* wage rate in a number of different wage rates, where such are in use, or if there should not happen to be an exact correspondence with any one rate, one will be closely approximated This may be demonstrated by considering the case of a shop with 7 employees at rates from 15 to 45 cts per hour Figure 7 shows (1) earnings or direct wages for month, (2) total productive hours for month, (3) average wage rate, which is 30 cts

An examination of the relation of hourly burden to this average wage rate follows

1. If overhead is $210, that is, 50 per cent on direct wages, then $210 ÷ 1,400 hr. gives 15 cts. per hour as burden, which it will be noticed is 50 per cent of the *average* wage rate.

2. If overhead is $420, that is, 100 per cent on direct wages, then $420 ÷ 1,400 hr. gives 30 cts. per hour as burden, which, again, it will be noticed is 100 per cent of the *average* wage rate.

3. If overhead is $630, that is, 150 per cent on direct wages, then $630 ÷ 1,400 hr. gives 45 cts. per hour as burden, which is 150 per cent of the *average* wage rate.

Intermediate amounts would obviously bear the same relations to the average rate.

It follows from this that whatever percentage overhead bears to direct wages, hourly burden will also bear to the *average* wage rate. It also follows that wage rates below this average are getting a higher share of burden than wage rates above the average, and *vice versa*, which in fact is the compensating principle for which advantage is claimed by the advocates of this system.

Rate, cents	15	20	25	30	35	40	45	Total
Hours worked	200	200	200	200	200	200	200	1,400
Dir. wage, dollars	30	40	50	60	70	80	90	420

Dividing total of wage rates ($2.10) by 7 gives the average wage rate as 30 cts. per hour.
Total hours worked in month taking hourly burden, 1,400.
Total direct wages, $420.

FIG. 7.—Direct-wage earnings and hours worked in a shop with 7 men at different wage rates.

When the Results Would Not Coincide.—Referring again to Figs. 5 and 6, it will now be clear why the two costs agree. It is because while overhead is 69.7 per cent of direct wages, the hourly burden, *viz.*, 48¾ cts., is *also* 69.7 per cent of the *average* rate per hour, *viz.*, 70 cts. (69.7 per cent of 70 = 48¾) and in this particular case *only this one rate is in use*. From this it follows that the burden taken up by work will be in proportion to both wages and hours in equal degree, with the necessary result that costs come out the same on both plans.

But, if wage rates had *not* been assumed as the same for all operators, and if some had been assigned rates as low as 30 cts. and some as high as 80 cts., then the estimates on the two methods would not have coincided at all. If the lower priced

men had preponderated in the total of working hours, one set of results would be forthcoming, and if the higher priced men preponderated, a different set Under these latter conditions it would be a matter of considerable investigation and argument to decide which of the results would be nearer to the truth

Neither Result Is Correct—Notwithstanding that the two methods gave results that appeared to confirm each other, we shall now ask whether either of them is correct As a preliminary to this inquiry, the costs of the same job worked out on the independent shop rates (Fig 8) will be presented It should be borne in mind, meanwhile, that the overhead for all the little shops taken together was *less* than the total overhead under the new, or factory, regime

Process	Est hours	Wages		Process costs		Total
		Rate, cents	Amount	Rate, cents	Amount	
10	30	70	$ 21 00	30	$ 9 00	$ 30 00
11	150	"	105 00	58	87 00	192 00
15	45	"	31 50	62	27 90	59 40
20	200	"	140 00	95	190 00	330 00
Total	425		$297 50		$313 90	$611 40

FIG 8—Same as Figs 5 and 6 at original process costs of the little shops

On comparing Fig 8 with Figs 5 and 6 it will be seen that while the first process, 10, is somewhat less in cost, the other three processes are considerably higher The total cost of the job, instead of being $504 as under the percentage and hourly burden plans, is increased to $611, no inconsiderable discrepancy and one which would probably make all the difference between profit and loss on this job

These costs (Fig 8) are not properly applicable to the consolidated business, but we cannot expect that, *if calculated by factors and process rates*, the operations of the consolidated business would show figures agreeing with Figs 5 and 6 If we assume that the new management had a knowledge of the process costs of the individual little shops before they were taken over by the new organization, it is probable that in these last results (Fig 8) food for thought would be perceived At any rate, the costs provided

by the percentage and hourly burden calculations would come under grave suspicion

Basis of Process Rates in the Little Shops —It is probable that, faced with this dilemma, the new management would endeavor to ascertain the basis of the process rates used by the little shops before consolidation, and this inquiry will be entered on in the next chapter

CHAPTER V

DETERMINATION OF RENTS AND PROCESS COSTS LITTLE SHOPS

One salient difference between the rents charged to the little independent shops for space, power and hire of machinery and the corresponding service factors which would be chargeable against individual processes under factory conditions must not be lost sight of. The former include the item of an outsider's *profit* on each service, since the suppliers of such services do not derive any benefit from the profits arising out of the manufacturing operations.

On the other hand, when the little shops are consolidated into one business and the individual producers become operators at wages, then the corporation derives its profits from the processing itself, and, consequently, the various services are charged against such processes *at cost*.

Service Factors Are Rents.—The similarity of service factors to rents otherwise is very close and, in the case of factors like the space and power factors, is almost complete, minus the item of profit. It is not even absolutely essential that profit on the service be excluded. If, for example, we suppose that the buildings are owned and maintained by a corporation organized separately from the business carried on in them, although the shareholders were common to both, or nearly so, then the charge made to the operating organization would be at one and the same time a true rent, a space factor, and would contain the item of profit.

The same considerations apply to the power factor. Conditions may easily be imagined in which the power plant was operated as a separate organization, supplying current or other form of power to other consumers, as for lighting a mill village or delivering power to an allied but entirely separate factory alongside the principal organization. In such cases the power would be billed to the various outside consumers and the various inside processes on their consumption and would include an item of profit.

Ordinarily, however, such services are confined to the operating organization, and, as the profits of such an organization are derived from manufacturing, the services would be supplied at cost, that is, without the inclusion of any charge for profit in the annual or monthly charge against production

Other service factors, such as those for superintendence, transport, etc, although on exactly the same lines as those for space and power, cannot very well be considered as rented from the outside in any case This, however, is a matter of practice and not of principle It would be quite *possible* to contract, for example, for all the internal transportation of a factory, and in such case the bill rendered monthly for such transportation would be a transport factor ready made The only difference between this and a transport factor arising from the firm's own operation would be that it would include an item of profit to the person with whom the contract was made

The fact that such services are, in practice, never rented or contracted for, does not in the least disturb the principle, which is that *each of these services is a distinct and entirely separate variety of activity*, the cost of which is capable of being expressed as a rent or service factor that has no relation or connection with any other class of activity, and which can be assigned with considerable precision to the different processes in proportion as each process calls on each service

Determination of Rent (Little Shops)—We have now to consider the form of accounting that is employed by the landlord of the buildings, power plant and machinery (used by the little producers in their independent shops) which enables him to bill each producer for his individual share of the total When this side of the transaction has been examined, the further side, that by which each producer translates these bills for rent into his process cost, will be considered

Rent of Building Space (Little Shops)—Figure 9 exhibits the mechanism used by the landlord for ascertaining and distributing his rents

The first step is to ascertain the annual cost This is comprised in the three items—interest, depreciation and repairs As other items, such as taxes, insurance, etc, are treated on the same lines they are omitted from the discussion

1 *Interest*—The interest here charged represents the ordinary interest on money which would be obtained if it were invested

in current securities instead of being locked up in a building It has no reference to the question of borrowed money, that is to say, whether the amount $43,000 invested in the building is wholly the money of the landlord or whether he has borrowed

Schedule for Rental of Building at——————

Amount of investment $43,000
Total space, 3 floors, 4,800 sq ft = 14,400 sq ft

Annual Rent of Whole Building

Interest	@ 6%	$2 580
Depreciation	" 5%	2 150
a Repairs	" 3%	1,290
b Profit	" 6%	2,580
Total		$8,600

NOTE —*a* Including cost of changing tenancies
b Including risk of unlet shops

Annual Rent per Sq Ft (Whole Building)

$\frac{\$8,600}{14,400 \text{ sq ft}}$ = average, 60 cts per sq ft

Rental per Sq Ft per Floor

Top floor rented @ 40 cts per sq ft
Middle " " " 50 " " " "
Ground " " " 80 " " " "

Floor	Area, sq ft	Rate, cts	Year	Month
Top	4,800	40	$1,920	$160
Middle	4,800	60	2,880	240
Ground	4,800	80	3,840	320
	14,400	av 60	$8,640	$720

FIG 9 —Landlord s schedule

some or most of it on mortgage makes no difference It is quite possible that a large part of the amount ($2,580) charged for interest does represent actual out-of-pocket expenditure, if, as we may suppose, most of the money has been obtained on mortgage, but whether this is true or not does not affect the fixing of the rent

The reasoning of this statement will be quite clear if we consider that, first, the owner must obtain a profit beyond the normal interest of money, or he would gain no advantage by risking it in the investment, second, if we assume that it is his own money that is invested and is producing him a profit beyond the regular 6 per cent, then if someone else's money partially replaces his own (that is, on the security of a mortgage) he ought not to make less profit on that account The only occasion on which he should be prejudiced in this way is in the event that he has made so poor a bargain in the borrowing of the money that the 6 per cent is not sufficient to cover it In this case the difference between the regular interest (6 per cent) and the borrowing rate (say, 7 per cent) is necessarily at his expense and comes out of his profit

In general, however, one lot of money in the hands of A should fetch in open market the same interest as a similar amount in the hands of B Consequently, before profit can be reckoned, a sum must be set aside which will provide interest at the normal market rate, and the first item ($2,580) represents this provision

2 *Depreciation* —Little need be said about this item at the present time The question of depreciation will be fully considered later It need only be pointed out that the amount charged ($2,150) is 5 per cent on the value of the building, and we must assume here that this rate has been assigned by expert advice, all the conditions of the structure having been taken into account It is obviously a provision that must be made and is not to be considered as to be taken out of profit

3 *Repairs* —Here we enter on more debatable ground That the building will cost something for repair is obvious, and that this amount must be provided for in fixing rents is also obvious The debatable consideration is the amount How much should be reserved or provided for in rent to allow for necessary repairs during the year?

In the case in question, it will be observed on reference to Fig 9 that 3 per cent on the value of the building has been so reserved A note is appended showing that some of this is chargeable in view of changing tenancies Shops when vacated require overhauling and making ready for a new occupier, and this is a charge additional to the ordinary repairs which would otherwise be sufficient

The basis of the charge for repairs is necessarily judgment and experience If the building has been let out in shops over a series of years or if access be had to the accounts of similar buildings, then it is a simple matter to ascertain the amount which will normally cover both the ordinary repairs and those due to change of tenants This amount has been expressed as a percentage on the value of the building but must not be understood as being ascertained in that way A depreciation rate is necessarily a percentage on value, but an allowance for repair is based on actual experience of the existing or some similar building, and its expression as a percentage is merely a matter of memorandum to give a general idea of the amount involved

4 *Profit* —While it is necessary to consider the final item, namely, profit, it is not requisite to discuss it at any length, because, as above intimated, it is an item that is peculiar to service taken from outside and will not be met with later when we come to consider the service factors for factory work

In the case of the independent shops, the amount to be added for profit will depend very largely on supply and demand for the particular class of building in question But in any case it will include an amount which is intended to cover the risk of empty shops This, again, is a matter for experience and judgement to fix It will vary in different places and even according to the prevalent kind of work carried on in the shops Whatever it may prove to be, this item completes the tale of charges[1] making up rent of the building The total amount, as given in Fig 9, is seen to be $8,600 per annum The next question is the division or distribution of this total over the twenty shops contained in the building

Determination of Rents for Separate Floors —Having obtained an annual total for the whole building, which total has to be recovered in individual rents, the simplest solution of the question of individual rent would be to prorate by the square feet occupied by each shop This, in fact, is what is necessarily done when a space factor under manufacturing conditions is being settled But in a commercial transaction like that we are now considering, the selling value of space is not the same for each square foot Space on the ground floor is more valuable than that on the floor above, while top-floor space is less valuable still

[1] As before stated, items like taxes, insurance, etc are omitted from the discussion

The reason for this has already been discussed, and, when it is remembered that no elevator service exists, it is sufficiently obvious. Therefore, while the average yearly rent per square foot is 60 cts., the landlord finds it convenient to attach a rent of 80 cts. per square foot to the ground floor, one of 60 cts. to the middle floor and one of 40 cts. to the top floor. No principle is involved except the familiar one of charging what the traffic will bear. As will be seen from Fig. 9, the result of this differentiation gives an assignment of $1,920 to be recovered as rent from the top floor, $2,880 from the middle floor and $3,840 from the ground floor.

Final Determination. Rents of Individual Shops.—Having now settled the rent to be charged per floor, the only remaining operation is to prorate the same over the shops on each floor. Figure 10 is a schedule for this purpose. On each floor, taken separately, the space occupied by each shop is multiplied by the square-foot rental for that floor, and the yearly and monthly amounts payable are entered opposite each shop number. Bills are made out monthly from this schedule.

Differences between Rents and Factors.—It has already been pointed out that one important difference between rents for service from outside (such as the rent for space just discussed) and factors suitable for factory operation is in regard to the inclusion of profits. This, however, may not be the only difference. As we have just seen, considerations of a commercial character may influence the method of distributing the total of such rents among the individual users. Nothing corresponding to this will be met with in factory practice. The difference in the rental of space on the different floors really masks contingencies that have no other value assignable to them, but which are implied in the difference of rental. In factory practice nothing of this kind occurs. If greater or lesser contingent expense to production is involved in a given location, it will appear in the accounts and be given its own place. While it has been thought well to dwell rather fully on these aspects of ordinary rents, it must be remembered that, while the fixing of rents for the little shops is neither mysterious nor complicated, the setting up of space factors for factory practice is simpler, because neither questions of profit nor commercial considerations have any place therein.

Schedule for Shop Rents

Shop No	Sq ft	Year rent	Month rent
1	600	$ 240	$ 20 00
2	400	160	13 30
3	600	240	20 00
4	700	280	23 30
5	350	140	11 60
6	350	110	11 70
7	850	340	28 50
8	950	380	31 60
Tot	4,800	$1,920	$160 00
9	720	$ 430	$ 35 50
10	580	350	29 50
11	1,000	600	50 00
12	750	450	37 50
13	950	570	47 50
14	800	480	40 00
Tot	4 800	$2 880	$240 00
15	750	$ 600	$ 50 00
16	900	720	60 00
17	650	520	43 40
18	700	560	46 60
19	600	480	40 00
20	1 200	960	80 00
Tot	4 800	$3,840	$320 00
Gd tot	14 400	$8,640	$720 00

FIG 10—Landlord s schedule for fixing shop rent Little shops

Determination of Power Rent (Little Shops)—Figure 11 presents the accounting scheme by which the owner of the small power plant (who, we assume, is the landlord of the building) ascertains (1) his power costs and (2) settles the amounts to be billed to each individual little producer

The annual and monthly charges are made up of interest, depreciation, repairs and profit as in the case of the building rent But, additional to these are the items of attendance, fuel and oil, or, in other words, the current expenses of power generation Having ascertained the current monthly charge and the normal horsepower furnished in the period of 200 working hours,

Schedule for Determining Power Rents

	Annual	Monthly
Investment in engine, boiler, belting, shafting pulleys, tanks & building		$3,000
Interest, 6%	$ 180	
Depreciation, 10%	300	$ 40
Powerman	$1,440	
Fuel and oil	1,740	
Repairs	180	280
Profit	$ 960	80
Total	$4 800	$400

Charge per Hp Hour

Shops take aggregate 9 hp for 200 hr per month = 1,800 hp hr
$400 – 1,800 = 22 cts per hp hr

Charges to Individual Users

Shop No	Hp	Amount	Shop No	Hp	Amount	Shop No	Hp	Amount
9	¼	$11 10	13	⅝	$27 65	17	⅝	$27 75
10	¼	11 60	14	½	22 20	18	¾	33 50
11	1	44 40	15	1¼	55 60	19	¾	33 50
12	⅜	16 55	16	⅞	38 85	20	1¾	77 80

FIG 11 —Landlord's schedule for fixing power rents Little shops

individual rents are ascertained by multiplying each shop's rated consumption by the charge per horsepower hour From this schedule bills are made out for each producer

Determination of Machinery Rents —It is assumed that each producer hires his machinery The charge made to him includes maintenance of the machines in working order, that is, all repairs are undertaken by the owners of the machines Figure 12 shows the accounting mechanism by which such owners fix the proper rent to be charged to each consumer

No	Value of machines	Depreciation		Interest 6%	Repairs		Total	Add profit 5%	Total chargeable	Monthly amount
		%	Amount		%	Amount				
1	$ 610.00	8	$ 48.80	$ 36.60	2	$ 12.20	$ 97.60	$ 30.50	$ 128.10	$ 10.67
2	390.00	10	39.00	23.40	2	7.80	70.20	19.50	89.70	7.47
3	550.00	6	33.00	33.00	3	16.50	82.50	27.50	110.00	9.16
4	800.00	10	80.00	48.00	4	32.00	160.00	40.00	200.00	16.66
7	800.00	12	96.00	48.00	2½	20.00	164.00	40.00	204.00	16.99
8	850.00	8	68.00	51.00	4	34.00	153.00	42.50	195.50	16.28
9	750.00	8	60.00	45.00	3½	26.25	131.25	37.50	168.75	14.05
10	450.00	9	40.50	27.00	3	13.50	81.00	22.50	103.50	8.63
11	1,050.00	10	105.00	63.00	3	31.50	199.50	52.50	252.00	20.99
12	750.00	7	52.50	45.00	2	15.00	112.50	37.50	150.00	12.49
13	950.00	6	57.00	57.00	2½	23.75	137.75	47.50	185.25	15.43
14	550.00	8	44.00	33.00	3½	19.25	96.25	27.50	123.75	10.30
15	900.00	9	81.00	54.00	3	27.00	162.00	45.00	207.00	17.24
16	1,500.00	8	120.00	90.00	3½	52.50	262.50	75.00	337.50	28.11
17	800.00	6	48.00	48.00	2	16.00	112.00	40.00	152.00	12.66
18	450.00	5	22.50	27.00	2	9.00	58.50	22.50	81.00	6.74
19	750.00	7	52.50	45.00	3	22.50	120.00	37.50	157.50	13.11
20	1 600.00	10	160.00	96.00	3	48.00	304.00	80.00	384.00	31.98
Tot	$14,500.00		$1 207.80	$870.00		$426.75	$2,504.55	$725.00	$3,229.55	$268.95

NOTE —Shops 5 and 6 having no machinery do not appear here

FIG 12—Schedule by which owners of machinery determine the monthly rental charges to lessees Little shops

As in the case of the building, the items that enter into the annual and monthly charges are interest, depreciation and repairs To these out-of-pocket items an additional amount for profit is then added, making up the total payable by the user of the machinery

Inspection of the schedule will show the details of this process The first two columns indicate the shop and the value of the equipment in it The next two columns give the depreciation rate and the amount of depreciation chargeable yearly Each set of equipment has its own proper rate of depreciation Interest (at the same rate, 6 per cent, for all equipment) comes next In the repairs column each set of equipment is rated at a figure which experience shows will cover the normal annual repairs

Depreciation, interest and repairs, representing out-of-pocket expenses, are then totalled, and to the total in each case is added a further 5 per cent on the capital value to represent the owner's profit A portion of this profit may be regarded as a provision against machines, returned to the owners, remaining unhired The remaining columns summarize the annual and monthly charges against each little shop From the last column the individual producer is billed month by month

Standardization Implied in All These Rents—Before considering how the little producer combines these bills to ascertain his process cost, it may be well to view these three types of rent at large and observe their characteristics In all three types the same principle is involved, namely, that which is now known as "standardization," a principle which is generally supposed to be quite modern but which really is as old as rents of any kind, that is, as old as civilization itself

Whenever it becomes desirable to assign a price to a service for a limited period, and such service contains variable factors, standardization becomes essential A depreciation rate is, for example, nothing but a standardized charge representing a somewhat vague fact, namely, the gradual decay of a building or a machine That such decay is not necessarily uniform must be apparent To consider the exterior alone of a great public building of which the life extends over centuries, it is obvious that climatic conditions will control the rate of decay to a large extent Long-continued periods of storm, extreme winters, heavy and exceptional snows, unusual spells of torrid heat—each of these has its own peculiar influence on the rate of

decay of the building and is entirely unforeseeable by any human effort

In the case of buildings of shorter life, such as those used in industry, all of these conditions apply though their cumulative effect will be less, but in addition, the vicissitudes of internal changes, alterations, destructive processes, unexpected weaknesses in structure, etc , all contribute to set up a variation in the rate of decay from year to year

Nevertheless, it has been found feasible, in practice, after close observation of different types of building under various working conditions, to reduce all these variations to an approximate or standardized rate of decay, which is termed a "depreciation rate" In the same way the gradual decay of various types of machines in different industries has been observed to a sufficient degree to permit of applying a standardized charge or annual depreciation rate that will fairly represent the manner in which machines wear out under ordinary conditions

Discrepancies in Depreciation Not Visible —The standardization of a charge to represent decay has, however, this advantage over others that we shall meet Errors in fixing the standardized rate cannot be detected over any limited period such as enters into accounting If a rate has been fixed too low, it will take several years to demonstrate the fact It will be clearly proved only by the necessity for discarding the machine when, for example, two-thirds instead of the full value has been recovered through depreciation But when more definite classes of expense are standardized, then it is necessary to scrutinize the actual effect of the assigned rate and observe whether, in fact, it does distribute the actual expense with sufficient accuracy over a reasonable period, say twelve months

Checking Accuracy of Standardization —Thus, in the case of rents such as we have been discussing, the amounts charged through such rents for an item like repairs need close watching to ensure, on the one hand, that sufficient reserve has been made to meet current expenditure on repairs, and, on the other hand, to ensure that too high an assessment for repairs has not been made This principle applies in even greater degree when items like the current expense of generating power are in question The fixing of a power rent is, therefore, a more difficult operation, or rather, demands more careful and precise consideration of details than does the fixing of a building rent The assessment

of a machinery hire rate stands probably on much the same footing as the rent of a building

In all these cases some simple mechanism has to be set up to keep tab on the expenditure In the case of building rent the payments for repairs, when totalled at the year-end, will, of course, provide the necessary check For the rental of machinery this would be amplified by analyzing the payments and posting them to the different machines, so that the actual repair incurred by each machine separately would be known The power station would require more elaborate accounting, inasmuch as the fuel, repairs, lubricant, labor, etc, would each be liable to over- or underestimate, and probably a monthly or weekly control might be considered worthwhile in this instance

Individual Producer's Process Cost—Having shown how the owners of the building, the power plant and the machinery determine their annual and monthly rents, which are then billed to each of the little shops, we may now consider what use is made of them by the latter At the month-end each producer will be in possession of at least three bills, namely, one for his shop rent, one for his power consumed, one for his machinery In one or two instances these may be supplemented by a further bill for storage space rented, as explained in the previous chapter

Shop 10 Process cost	
Bill for rent	$29 50
Bill for power	11 10
Bill for machine	8 63
Rent of storage	11 70
Total	$60 93
Hr rate (200 hp per month) 30 cts	

FIG 13—Individual producer's method of calculating his process cost

Figure 13 shows how each such producer deals with these bills The example shown is for shop 10, the producer in which also rents room 6 as extra storage The bills are simply listed and aggregated, making a monthly total of $60 93 payable by the little producer

Now, of what does this $60 93 represent the cost? If we assume that the power supply is limited to 200 hr per month, then it is obvious that a *maximum* of 200 hr production is implied

in the charge Dividing, therefore, $60 93 by 200 gives an hourly-process cost of $0 3046 or practically 30 cts per hour

If it is assumed that one article per hour is turned out, then the cost of this article will be 30 cts for process cost, to which must be added an amount representing the producer's own wages, say 70 cts per hour, and, of course, the cost of raw material, if any

No Alternative to This Cost—It does not seem possible to imagine any alternative figure for such cost As long as the

Shop No	Rent as Fig 10	Power as Fig 11	Machinery as Fig 12	Total for month	Hourly rate, cents
1	$ 20 00		$ 10 67	$ 30 67	15
2	13 30		7 47	20 77	10
3	20 00		9 16	29 16	15
4	23 30		16 66	39 96	20
5	11 60			11 60	
6	11 70			11 70	
7	28 50		16 99	45 49	23
8	31 60		16 28	47 88	24
9	35 50	$ 11 10	14 05	60 65	*a*36
10	29 50	11 10	8 63	49 23	*b*30
11	50 00	44 40	20 99	115 39	58
12	37 50	16 55	12 49	66 54	33
13	47 50	27 65	15 43	90 58	45
14	40 00	22 20	10 30	72 50	36
15	50 00	55 60	17 24	122 84	62
16	60 00	38 85	28 11	126 96	64
17	43 40	27 75	12 66	83 81	42
18	46 60	33 50	6 74	86 84	44
19	40 00	33 50	13 11	86 61	43
20	80 00	77 80	31 98	189 78	95
Total	$720 00	$400 00	$268 96	$1,388 96	

NOTE—Hourly rate for 200 hr per month (*a*) including rent of storage 5, (*b*) including rent of storage 6

FIG 14—Tabulation of the process cost in each of the 18 productive shops

rents are maintained at the given figure and the maximum working capacity stands at 200 per month, then Fig 13 must represent the true and only cost of a process hour And, similarly, Fig 14, which exhibits in tabular form the process costs which would be obtained by all the shops, presents hourly-

process costs that cannot possibly be imagined as different on any method of calculation It will be observed that these rates vary from 10 to 95 cts per hour for processing costs alone

The Effect of Shorter Working Hours—If the producer in shop 10 can produce at a process cost of 30 cts an hour *when he avails himself of the full manufacturing facilities for which he pays by means of his different rents*, that is the figure he would make use of in bidding for work But let it be supposed that from illness or a fit of idleness, he works only 150 hr in any given month How is he to regard the effect of this idleness on his costs? Would it be correct for him to say that his process cost was greater on this account? If he divides $60 93 (the total of his month's rents) by 150, a new process cost of $0 4062, or say 40 cts an hour, results Is there any meaning in this latter figure, and would he be justified in applying it in his calculations of cost?

There does not seem any occasion on which this new figure could be usefully applied to costing purposes Nor is it probable that the little producer would think of so doing He would know quite well what had happened, namely, that a portion of the manufacturing capacity for which he was paying rent had been *wasted* Without doubt he would say to himself This month my output has been 150 pieces, which, at 30 cts an hour, gives $45 I have wasted 50 hr, and the value of the time I have wasted is $50 \times 30 = \$15$ Used time ($45) and wasted time ($15) makes up $60, the amount of my rents

It would, of course, be easy for him to calculate that the 150 pieces he had produced were all he had to show for an expenditure of $60, and, therefore, that each had cost him 40 instead of 30 cts, as they should But it is difficult to see of what value such knowledge would be to him It would be a purely accidental figure that depended on the actual number of pieces made If next month he wasted 100 hr and produced only 100 instead of 150 pieces, another new figure would result, namely, 60 cts each But neither of these results would have any particular meaning, and it is almost certain that a little producer of this kind would ignore any such calculations On the other hand he would certainly recognize that failure to work 200 hr in the month meant wasted opportunity, which affected his pocket but did not increase the cost of what was actually made It would be of great importance to him to know the cost

of his process hour based on a full month of 200 hr, but variations of this based on short time would be of no value to him for bidding or for any other purpose

Composition of Process-hour Costs —While the tables already given provide a clear picture of the way in which the rents paid by each little producer are built up, it may be well to exhibit the different process costs throughout the eighteen shops in the form of a diagram (Fig 15) This diagram shows graphically

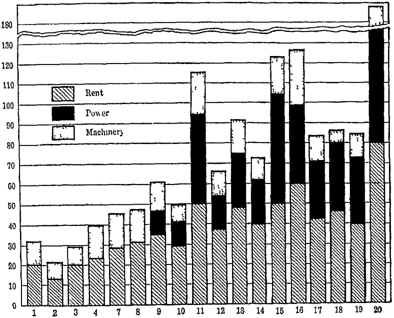


FIG 15

the difference in dimension of the various process rates and also in what measure each is built up out of the three kinds of rents heretofore mentioned The diagram shows the total monthly debit against each shop and its composition Naturally, the process hour is of the same composition in the same proportion

Conditions for Increased Cost Per Piece —While the process cost itself cannot be considered as a variable, inasmuch as it represents the price paid for manufacturing capacity by each little producer, whether he uses it all or not, the cost *per piece* will, of course, vary in direct proportion to time occupied in

processing If, for example, it requires only ½ hr to complete the work on one piece, then the cost per piece will be as follows

	Cents
Process cost ½ hr @ 30 cts	15
Wages ½ hr @ 70 cts	35
Complete cost per piece	50

instead of $1 as before

Combined Process and Wage Rate —As in this case the same rate of wages (70 cts), is always associated with the same process rate (30 cts), it is evident that the calculation of cost would be simplified by consolidating the two rates The combined rate would be $1 per hour, and this figure would be used by the producer for all purposes for which costs are employed, as in bidding on new work

It will be noticed that the wage rate also is really based on a working time of 200 hr per month, or, rather, on one of 50 hr per week On a preceding page it was mentioned that the producers' wages were fixed at $35 per week, on the idea that if employed by others, this is the wage they would expect The little producer is then in the position of expecting that his work shall yield him, first, 200 hr × 30 cts or $60 which will enable him to pay his three varieties of rents, and, second, 200 hr × 70 cts or $140 which will enable him to fill his pocketbook with notes to the same extent as if employed Whatever returns he gets above these two amounts is profit due to his work as *entrepreneur* or organizer, or, in other words, to his operations as a "captain of industry" on a tiny scale

It will be observed that failure to work the whole 200 hr per month has a similar effect both on his pocketbook and on his indebtedness If he idles 20 hr , he loses 20 × 30 or $6 on his rents and, also, 20 × 70 cts or $14 on his wages He fails to utilize his manufacturing capacity to the extent of $6 and he fails to utilize his own personal earning capacity to the extent of $14 In each case the essential fact is *wasted opportunity* and this leads to financial loss, but cannot be regarded as having increased the cost of what work was actually done

True Cost Is Not Increased by Short-time Work —The notion of rising and falling costs (percentages or hourly burdens) is so firmly rooted that many persons may be found to argue that, in point of fact, the little producers' costs do actually rise and

fall, that when he has worked 200 hr per month his burden is 30 cts per hour and when only 150 hr it is really 60 cts

While it is wholly improbable that a little producer under the conditions here set out would ever think in this way, because the true cause of decreased output would always be known intimately to him, there is another reason why these purely arithmetical ratios cannot be regarded as true costs

Let us consider the case of a series of weeks, as exhibited in Fig 16, grouped in 4-week months and of varied working hours It can be demonstrated that while the true process cost is always the same, the process cost as shown by an hourly burden method will vary according to the position of the dividing line

	First month				Second month				Third month			
Hours worked per week	50	45	50	30	50	50	50	40	50	50*	50	20
Total	175				190				170			

* Cost of process for these 50 articles (1 per hour)
Process rate 30 cts Hours 50 Process cost $15
Hourly burden plan Monthly burden $60 Hours worked in month 170 (60 ÷ 170 = 35 cts per hour)
Process cost of 50 pieces (1 hr each) = $17 50

Fig 16 —Process cost (shop 10) on certain weekly outputs

The question to be investigated is What is the process cost of the 50 articles made in the second week of the third month (marked by a star in the figure)? On the basis of figures already given, namely, one article per hour at a process rate of 30 cts , the cost of the 50 will be $15 For the whole month the little producer would say that he had used 170 hr and wasted 30 hr But on the hourly burden plan the process cost would be $17 50 (see figure)

Let it be considered that, with the same series of outputs per week, the dividing line between 4-week periods came not after the final week with an output of 20 but before it Under these conditions, what would be the process cost of the above-mentioned 50 articles? The cost on the process-rate plan would be as before, but the cost by the hourly burden plan would not As shown by Fig 17, it now appears as $15 75, a difference of $1 75 from the former hourly burden cost

It is obvious that if a mere shift of the dividing line between periods can give such very different hourly burdens for exactly the same outputs, then there is here something which is not true cost (except by an accidental coincidence), but is a mere arithmetical device arbitrarily to connect burden with manufacturing operations. But the matter may be argued also on other grounds.

	Second month				Third month				Fourth month			
Hours worked per week	30	50	50	50	40	50	50*	50	20			
Total	180				190				Incomplete			

* Cost of process for these 50 articles
Process rate cost as Fig. 16.
Hourly burden cost. Monthly burden $60. Hours worked in month 190 ($60 ÷ 190 = 31.5 cts.). Process cost of 50 pieces (1 hr. each) $15.75.

Fig. 17.—Cost of same output. Financial period shifted one week to left.

Process Cost Variations Not Retrospective.—The most determined apologists for percentages and hourly burdens do not go so far as to assert that the conditions under which work is done *today* affect the cost of what was done *last month*. If, then, since the beginning of any given month, 50 hr. have been worked in each of 3 weeks so that 150 hr. have been worked in all and 150 pieces turned out, then all the working time will have been fully employed, and the cost of the pieces done will be 150 × 30 or $45. Let it be supposed, further, that in this case it was customary to bill every 3 instead of every 4 weeks, then, as the financial period would be 3 weeks, the cost of the work would be the same by the process-rate method and the hourly-burden method (working time having been 100 per cent).

If, now, in the next week the shop worked only 20 hr., not even a percentage advocate would claim that the costs of the previous period *just closed* were affected by this. No stretch of imagination would enable one to assert that a failure to utilize manufacturing capacity today had any effect on the cost of work which was done and gotten rid of in the previous period.

But, if the 3-week period is extended to 4 weeks, so as to take in this last week of which the working hours were only 20, then for the 4 weeks there would be a working time of 50 + 50 + 50 + 20 or a total of 170 hr., and, under these conditions, an hourly

burden system would give a figure of 35 cts for all the work, both that done in the first 3 weeks and that done in the fourth week

But this implies that the hourly burden plan will give different results according to the number of weeks taken into the working period This corresponds to no useful or valuable fact in the actual operations

The most significant feature of percentages and hourly burdens is that until the end of the working period, whatever that may be, no one knows what the "cost" of any article will turn out to be In the case just cited, though the first 3 weeks production was entirely normal and if considered by itself would give a process cost of 30 cts an hour on either method, all this is ignored and everything must wait until the end of the fourth week, which, owing to its particular shortcomings, increases the cost for the whole period to 35 cts

Little Shops Exhibit Fundamentals of Burden —The discussion of primitive conditions as above described has been extended for the reason that we have here the most elementary and fundamental exhibit of the relations of burden to process work that it is possible to find No one can doubt that the bills received by the little producer are his overhead, or that his hourly process rate is anything but an accurate one It has been shown that the *cost of manufacturing capacity*, as represented by the process rate, is one single and unalterable figure It has also been shown that any failure to utilize the whole of this capacity would be recognized by the individual producer as wasted opportunity which must be paid for out of his own pocket, but which has no relation to the *cost at which work can be done*

It has been demonstrated that each of the eighteen shops has an absolutely different and individual debit for burden and, hence, a different process rate Further, it has been shown that variations in process cost furnished by hourly burden have no significant meaning and are of no value for bidding, estimating or any other usual cost purpose

In the next chapter we shall consider the same set of eighteen shops brought under one financial control, with the partitions thrown down and factory conditions established The question will then arise as to how far the accurate process rates individual to each production center (corresponding to the former shops) can be preserved under factory conditions

CHAPTER VI

FACTORS AND PROCESS RATES IN THE CONSOLIDATED SHOPS

Calculation of the various factors that go together to make up the overhead of a factory is a somewhat simpler matter than compilation of rent charges as exhibited in previous chapters We have to consider only the *standard cost* of services on the one hand and how each production center *shares* in such services These being settled, the only remaining question is the number of hours that is to make up the standard month and year

Schedules of Service Factors Consolidated Shops —Figures 18*a* to 18*f* represent the various standardized factor schedules as arranged for the shops under discussion after factory conditions have been introduced These will be dealt with separately

1 *Buildings or Space Factor* —The question here is to establish an annual figure which will closely represent the actual cost of maintaining the building in a condition fit for manufacturing operations It differs from the landlord's rent schedule (Fig 9) in several points First, there is no item of profit included Second, the amount for repairs is set at 2 instead of 3 per cent The smaller amount is judged to be sufficient to cover the average repairs, inasmuch as there is now no question of change of tenancies with the corresponding need for doing over the shop each time Third, a new item appears, namely, that for cleaning When the little producers were working on their own account, their cleaning would be done by themselves out of working hours It would, therefore, cost them nothing out of pocket, yet, in a sense, would be taken out of profits if the time so occupied were considered worth anything at all Now, however, profits are taken by the concern, and, in this case, the cost of cleaning necessarily falls on the concern itself Its annual cost must therefore be included in the schedule

The other items are similar to those on the landlord's rent schedule Interest at 6 per cent and depreciation at 5 per cent

Fig 18*a* Buildings or Space Factor		
Capital value $50,000	Interest 6%	$3,000 00
Square feet 14,400	Depreciation 5%	2,500 00
Space factor	Repairs 2%	1,000 00
$6,980 ÷ 14,400 = 48½ cts per sq ft per annum	Cleaning	480 00
		$6,980 00

Fig 18*b* Power Factor		
Capital value $3,000	Interest 6%	$ 180 00
Horsepower hours	Depreciation 10%	300 00
9 hp 2,400 hr = 21,600	Power man	1,440 00
Power factor	Fuel & oil	1,740 00
$3,840 − 21,600 = $0 1777 per hp hr	Repairs	180 00
		$3,840 00

Fig 18*c* Individual Machine Factors		
Capital value $14,500	Interest 6%	$ 870 00
The calculation of the individual factors is given in Fig 12 as prepared for the independent shops The three right-hand columns, which include lessor's profit, are ignored	Depreciation	1,207 80
	Repairs	426 75
		$2,504 55

Fig 18*d* Transport Factor		
Transport man $1,200	Services judged to be distributed	
	Top floor 33%	$ 400 00
	Middle floor 50%	600 00
	Ground floor 17%	200 00
		$1,200 00

Fig 18*e* Superintendence Factor		
Superintendent $2,640	Services judged to be distributed	
	Process 1–8, 20%	$ 528 00
	" 9–14, 35%	924 00
	" 15–20, 45%	1,188 00
		$2,640 00

Fig 18*f* Organization Factor		
Manager	$2,880 00	Services judged to be distributed equally over all (18) processes $4,080 ÷ 18 = $266 66 for each process
Clerk	960 00	
Office expense	240 00	
	$4,080 00	

Figs 18*a* to 18*f* —Calculation of service factors under the new organization Consolidated shops

are included, but the amounts are different in consequence of the price paid by the new concern being higher than the original value on the landlord's books

The aggregate of these charges stands at $6,980 per annum It should be clearly understood that *this is a standardized charge* It represents the best judgment of what should be and will be incurred for the maintenance and upkeep of the building for one year (As before explained, certain items such as taxes and insurance are ignored here to simplify the treatment) It is not mysterious or difficult but exactly the same kind of calculation that should have to make if, instead of using the building for our own purposes, we were preparing to rent it to someone else, except for the small variation in items just mentioned Having arrived at this total, the next step is to observe how it is to be distributed between production centers

The first step is to reduce this total to a square-foot basis The entire working space being listed, as in the landlord's schedule (Figs 10 and 19), an aggregate of 14,400 sq ft is found Dividing this into the annual charge, we obtain a standardized annual charge per square foot of 48½ cts This is the annual space factor

2 *Power Factor* —This schedule corresponds to the landlord's power-rent schedule (Fig 11) As the power plant was taken over by the new concern at the price it stood on the landlord's books, this schedule is exactly the same as that shown in Fig 11, with the exception that the item of profit ($960) is now omitted This deduction makes the new standardized power charge stand at $3,840 per annum, and, as the consumption is rated as before, *viz* , 9 hp , we have a lower annual charge per horsepower The standardized power factor thus stands at 0 1777 per horsepower hour

3 *Individual Machine Factors* —Figure 18c corresponds to the left-hand half of the machinery owners' rental schedule (Fig 12) up to and including the column headed Total The machinery having been taken over at book value from the original owners, there is no modification in any of the figures, but, of course, the figures at the right of the column Total no longer apply, as they include the item of owners' profit Figure 18c summarizes the legitimate figures, which now stand at $2,504 55 for the annual charge to individual machines Distribution to these machines will be discussed later

4 *Transport Factor* —We now come to an item entirely new and not corresponding to any expenditure incurred by the little producers when they were on an independent basis As in the case of cleaning, it may be assumed that the handling of raw material and of finished product, packing and unpacking of goods, etc , was accomplished by the individual producers in their non-working time, that is, out of profits Now, however, this class of work must be undertaken by the firm, and the transport factor represents the annual cost of such work It is made up of a single item, namely, the wages of the transport man employed on the job

This part of the transaction presents no difficulty, as it is self-evident, but the question of the distribution of this new item among the different production centers demands careful consideration No ready-made formula can be applied to solve this and similar problems Careful observation of facts will alone serve In this particular case observation is assumed to have resulted in a record that one-third of the man's time was spent in serving the top floor, half in serving the middle floor and the remainder in serving the ground floor His time (which represents the transport factor in this case) is, therefore, allotted to the three floors in the proportions of 33, 50 and 17 per cent, respectively The manner in which these localized charges are passed on to individual machines will be shown later

5 *Superintendence Factor* —This schedule (Fig 18*e*) also contains but one item, that of the superintendent's salary It would, of course, in the case of a factory on a large scale, contain many more The scope of the superintendent in this particular case was discussed in a former chapter, all that has to be considered here is on what basis his salary, representing the superintendence factor, is to be distributed among individual production centers

This again is not a matter of formula but of observation In many instances it might be that observation would show that each production center had an equal share in the labors of the superintendent, and, in other cases, of which this particular case is assumed to be one, it might be found that his work was more concerned with, or, to put it another way, his time was more occupied by, jobs proceeding from certain groups of production centers than with those proceeding from others In this case, observation is assumed to have shown that processes 1 to 8,

took 20 per cent of his attention, processes 9 to 14 occupied 35 per cent and the remaining processes, 15 to 20, absorbed 45 per cent. Within each of these groups the individual machines were considered to share alike, as will be shown later.

6. *Organization Factor*.—All of the overhead expenditure incurred in maintaining the factory as a running affair has now been considered with the exception of the class of expense often called "administrative" or "general" expense, representing the salaries of office men, managers and their current expenses. Figure 18*f* schedules the standardized annual expense of this class under the title "organization factor." In this case the salaries of the manager and clerk, aggregating $3,840 per annum, and office expenses, such as phones, stationery, traveling expense, postage, etc., are set down as amounting to another $240 per annum.

Buildings or space factor	$ 6,980
Power factor	3,840
Individual machine factors	2,504
Transport factor	1,200
Superintendence factor	2,640
Organization factor	4,080
	$21,244

FIG. 18*g*.—Summary of schedules 18*a* to 18*f*.

In this particular case it is assumed that no one of the production centers is concerned with this expenditure more than another. In other words, the total $4,080 per annum is to be distributed pro rata among all the centers. But this, of course, is by no means necessarily true. In a large business, divided into departments, it does not follow that some departments would not absorb more of the activity of the management than others. This aspect of the matter will be dealt with in detail in later chapters, and it need only be noted at this stage.

7. *Making Use of the Standardized Factors*.—We have now assembled in schedule form the standardized annual expenditure of every kind that enters into maintaining the plant in running order. Figure 18*g* shows the factors that have been established.

Aggregate of Factor Cost.—What does this represent? Obviously, it represents the cost of the manufacturing capacity of the plant *as a whole* for one year. And as the "plant" is for all practical purposes nothing but an assemblage of processes or

production centers and the accessories and services that enable them to produce, the statement implies that this $21,244 is the cost of preparedness for production through and by the operation of processes or production centers If the working year is set at 2,400 hr, then we may say that 2,400 hr manufacturing capacity will cost $21,244, or about $8 85 per hour As there are 18 active production centers, this would mean that the *average* cost of manufacturing capacity per production center per hour was in the neighbourhood of 49 cts This figure is, in fact, almost identical with the hourly burden calculated from the first monthly return (Fig 2) made by the new organization and given in Fig 4

The object, however, is to dispense with averages It will be quite evident, from what has already been said and from an inspection of the chart (Fig 15), that any average of this kind would give the same processing cost for production center 2 as for 20, while the actual calls on service of the two centers is vastly different Our next step, therefore, must be so to allot the various service costs that each individual production center gets its own just share and that only This implies that for each factor there is some special basis on which the allotment can be carried out, and, as a matter of fact, this basis is but rarely a simple arithmetical division

Calculation of Process Rates Consolidated Shops—Figure 19 presents a schedule by aid of which the allotment of factor charges to individual production centers may be carried out In the first column the production centers (which correspond to the individual little shops of the former regime) are listed in order The remaining columns deal with the allotments

1 *Space Factor Allotment*—The working space for each production center was determined for the purpose of rent distribution in the landlord's schedule (Fig 10), and it is assumed that these are unchanged It is then only necessary to multiply each working area by 48 5 cts, the annual space factor, in order to ascertain the individual share of each production center It will be noticed that the allotment results in a range of annual charges for space varying from $194 for No 2 to $582 for No 20

2 *Power Factor Allotment*—The next two columns deal with the allotment of the power factor Production centers 1 to 8 have, as before, no power The remaining centers are rated for *consumption* as on Fig 11 (landlord's power schedule) Against

the rating of each center is placed the cost of that center's power for one year The total for all centers ($3839 89) corresponds closely with the total for the factor ($3,840)

3 *Machinery Factor Allotment*—The machinery having been taken over at the book figures of the former owners, the schedule prepared by them (Fig 12) for determination of their monthly rents will also serve for individual machinery factors under the consolidated regime, with the exception that now no profit is to be included The figures set against each production center in Fig 19 will, therefore, be those which appear in the column headed Total in Fig 12 The items include interest, depreciation and repairs, the two latter items being individually calculated for each separate production center as before explained The total for all production centers ($2,504 55) corresponds exactly with the amount in the schedule (Fig 18c) which summarizes the annual charge for individual machinery factors

4 *Transport Factor Allotment*—As explained above, observation of the work of the transport man resulted in the fixing of a differential share of his services as between floors in the proportion of 33, 50 and 17 per cent, respectively This means that the eight production centers (including storage rooms 5 and 6) on the top floor have to absorb $400, which is $50 each Six production centers on the middle floor have to take up $600, which is $100 each, while the six centers on the ground floor take up only $200, or $33 each These amounts are accordingly set against the respective machines The total for all centers ($1,200) corresponds exactly with the total of annual charge on the schedule (Fig 18*d*)

5 *Superintendence Factor Allotment*—In the same way the superintendence factor is made a differential charge as between groups of machines 1 to 4 and 6 to 8 (omitting, of course, 5 and 6 which are storage rooms) take 20 per cent, or $88 each, 9 to 14 take 35 per cent, or $154 each, while 15 to 20 take 45 per cent, or $198 each These amounts are set against the respective machines, and the total for all production centers ($2,640) corresponds exactly with the total of the annual charge on the schedule (Fig 18*e*)

6 *Organization Factor Allotment*—This factor, representing the general expense of the business, has been judged to bear equally on all production centers, and all that is necessary is to divide the total of the schedule of annual charge (Fig 18*f*)

No	Space		Power		Machy	Trans	Storage	Suptce	Org'n	Yearly total	Month (200 hr)	Hour rate
	Sq ft	Amount	Hp	Amount								
1	600	$ 291 00			$ 97 60	$ 50 00		$ 88 00	$ 226 66	$ 753 26	$ 62 76	31 4
2	400	194 00			70 20	50 00		88 00	226 66	628 86	52 40	26 2
3	600	291 00			82 50	50 00		88 00	226 66	738 16	61 51	30 7
4	700	339 50			160 00	50 00		88 00	226 66	864 16	72 01	36 0
5	350	169 75				50 00						
6	350	169 75				50 00						
7	850	412 25			164 00	50 00		88 00	226 66	940 91	78 40	39 2
8	950	460 75			153 00	50 00		88 00	226 66	978 41	81 53	40 7
9	720	349 20	¼	$ 106 66	131 25	100 00	$219 75	154 00	226 66	1,287 52	107 28	53 6
10	580	281 30	¼	106 66	81 00	100 00	219 75	154 00	226 66	1,169 37	97 43	48 7
11	1,000	485 00	1	426 66	199 50	100 00		154 00	226 66	1 591 82	152 64	66 3
12	750	363 75	⅜	159 99	112 50	100 00		154 00	226 66	1,116 90	93 07	46 5
13	950	460 75	⅝	266 66	137 75	100 00		154 00	226 66	1,345 82	112 14	56 0
14	800	388 00	½	213 33	96 25	100 00		154 00	226 66	1,178 24	98 18	49 0
15	750	363 75	1¼	533 32	162 00	33 00		198 00	226 66	1 516 73	126 38	63 2
16	900	436 50	⅞	373 32	262 50	33 00		198 00	226 66	1,529 98	127 49	63 7
17	650	315 25	⅝	266 66	112 00	33 00		198 00	226 66	1,151 57	95 96	47 9
18	700	339 50	¾	319 99	58 50	33 00		198 00	226 66	1,175 65	97 96	48 9
19	600	291 00	¾	319 99	120 00	33 00		198 00	226 66	1,188 65	99 05	49 5
20	1,200	582 00	1¾	746 65	304 00	35 00		198 00	226 66	2 092 31	174 35	87 2
Tot	14,400	$6,984 00	9	$3,839 89	$2,504 55	$1,200 00		$2,640 00	$4,079 88	$21 248 32	$1,770 54	

FIG 19 —Calculation of process rates under the new organization Consolidated shops

by 18, which gives $226.66 per production center. This amount is set against each center, and the total, $4,079.88, corresponds within a few cents with the total of the schedule.

7. *Yearly Charge against Each Production Center.*—Cross-totalling gives the yearly charge against each center, with a total of $21,248.32 for all centers, which total is within a few dollars of the aggregate of all schedules (Fig. 18*d*).

8. *Monthly Charge against Each Production Center.*—Dividing each annual charge (which represents 2,400 hr. of production) by 12, we find the monthly charge for 200 hr. The total monthly charge for all centers amounts to $1,770.54. If this figure is divided by 200 it gives an hourly charge of $8.85 *for the whole plant*, as forecasted on a previous page.

9. *Process Rates.*—The monthly amount standing against each production center being divided by 200 (hr.) gives the *hourly process rate* for each center. These rates vary from $0.262 per hour in the case of group 2 to $0.872 per hour in the case of group 20. The *average* hourly rate which is found by dividing $8.85 by 18 is $0.491, as already mentioned above. This would correspond *with the hourly burden rate* when all centers *were running the full* 200 *hr.* per month, but even under such full-time conditions (which are the most favorable conditions for hourly burden or percentage systems), it will be seen that there is a woeful failure to give any accurate picture of actual process costs, *except in the case of those production centers that happen to carry a rate which is near the average*. In this particular case, only one center (19) which has a process rate of $0.495 can be said to be closely represented by this average or hourly burden rate.

Fresh Estimate of the Former Job on the New Rates.—Having now established process rates for all the production centers under the consolidated business regime, we may now take the question of estimating on the job (Figs. 5, 6 and 8) and apply the new rates to the different items.

Figure 20 shows the resulting estimate. It will be remembered that the same job was figured before on various bases, with the following results:

On the percentage basis (Fig. 6)	$504.84
On the hourly burden basis (Fig. 5)	504.67
On the process rates of the little shops (Fig. 8)	611.40

To these we may now add:

On the process rates of factory (Fig. 20)	614.40
On the new hourly burden ($0.491)	506.17

The last calculation ($506 17) is not shown in detail but is the same as Fig 5, except that the new hourly burden (for the consolidated shops) is substituted for the former hourly burden The slight difference between the two hourly burdens is due to the fact that the actual expenditure as recorded in the monthly statement (Fig 2) does not correspond *exactly* with the standardized amount in the schedules This will be referred to again

Interpretation of These Results —It will be seen that if all of the overhead is averaged over the working hours, an average rate, or hourly burden of $0 491 results, which gives a total cost of $504 to $506 for the job, according as we take the standardized or actual monthly expenditure When the overhead is not averaged but allotted to production centers in proportion as these

Process	Est hours	Wages		Process cost		Total
		Rate, cents	Amount	Rate, cents	Amount	
10	30	70	$ 21 00	48 7	$ 14 61	$ 35 61
11	150	"	105 00	66 3	99 45	204 45
15	45	"	31 50	63 2	28 44	59 94
20	200	"	140 00	87 2	174 40	314 40
Total	425		$297 50		$316 90	$614 40

FIG 20 —Job estimated on process costs of the new organization (Compare Figs 5 6 and 8)

call on the various services which compose overhead, a quite different figure, namely, $614, results The reason this job comes out much higher on the process-rate method is because those production centers concerned with it *have rates much above the average*, with one exception, which is only slightly below the average

On the other hand, the close coincidence between the cost of the job on the new process rates and on the rates used by the little shops is an accidental one Comparison of Fig 8 (little shops) with Fig 20 (new regime) will show that some rates are higher and some lower in the new regime Consequently, the fact that these two costs have come out close together is accidental and depends on the cancelling out of increases and decreases so as to make an even sum This instance, in fact, provides another piece of evidence against too hasty belief in accuracy because

costs on one method appear to be confirmed by costs taken out on another

The one significant deduction from comparison of the two sets of figures is that, notwithstanding it has been assumed in both cases that shops were working full time, the ordinary hourly burden method has wholly failed to give expression to the truth—that the production centers concerned in this job cost more to run, that is, the cost of their manufacturing capacity is considerably greater than that of others not concerned in the job

Costs of Another Job Considered—In order to exhibit more fully the relations between process-hour rates and hourly burdens,

Process	Est hours	Wages		Overhead		Total
		Rate, cents	Amount	Rate, cents	Amount	
1	45	70	$ 31 50	15	$ 6 75	$ 38 25
2	200	"	140 00	10	20 00	160 00
3	150	"	105 00	15	22 50	127 50
4	30	"	21 00	20	6 00	27 00
Total	425		$207 50		$55 25	$352 75

Fig 21a—Second job estimated at little shop rates

Process	Est hours	Wages		Overhead		Total
		Rate, cents	Amount	Rate, cents	Amount	
1	45	70	$ 31 50	48¾	$ 21 93	$ 53 43
2	200	"	140 00	"	97 50	237 50
3	150	"	105 00	"	73 12	178 12
4	30	"	21 00	"	14 62	35 62
Total	425		$297 50		$207 17	$504 67

Fig 21b—Second job estimated on hourly burden

the case of another job, processed principally on the less important production centers, may be taken Figure 21a deals with this job on the basis of the original little-shop rates Production centers 1, 2, 3 and 4 are concerned, with rates of 15, 10, 15 and 20 cts, respectively Figure 21b deals with the same job at the hourly burden rate (48¾ cts) Figure 21c is concerned with the

same job, but here the new process rates for the consolidated business are used The results may be tabulated thus

On the original little shop rates	$352 75
On the consolidated shops hourly burden	504 67
On the consolidated shops process rates	420 88

Process	Est hours	Wages		Overhead		Total
		Rate, cents	Amount	Rate, cents	Amount	
1	45	70	$ 31 50	31 4	$ 14 13	$ 45 63
2	200	"	140 00	26 2	52 40	192 40
3	150	"	105 00	30 7	46 05	151 05
4	30	"	21 00	36 0	10 80	31 80
Total	425		$297 50		$123 38	$420 88

FIG 21c—Second job estimated at process rates

Interpretation of These New Results—One feature in these results will be noticed at once on comparing them with the figures of the preceding job The costs of the former job ran in this order hourly burden $504, little shops $611, new process rates $614 But in the case of the job now being considered, the order is different, namely little shops $352, new process rates $420, hourly burden $504 In other words, the hourly burden cost instead of being lowest is now highest

The reason for this is not far to seek It is simply that the production centers concerned in this new job happen to have process rates *below* the average They represent a less expensive class of equipment as far as running cost is concerned Consequently, hourly burden brings out the cost of the job far too high, even though in this case, as in the other, the shops are considered as running full time If, on the contrary, they were not running full time, the cost as calculated by hourly burden would be higher still

Comparison of the Two Jobs from Another Viewpoint—It will have been observed that both these jobs, the old and the new, took the same total time to process, namely 425 hr, although each job was done by a different set of production centers While, therefore, the calculation of cost by means of process rates gives the following

1st job, 425 hr, direct wages $297 50, process rates $316 90, total $614
2d job, 425 hr, direct wages $297 50, process rates $123 38, total $420

the calculation of cost of these two jobs by the hourly burden method gives *precisely the same cost for both,* namely,

1st and 2d } 425 hr., direct wages $297 50, hourly burden $207 17, total $504 67

it being remembered that in all of these cases full working time of all production centers is assumed.

Now, if the arguments in this chapter have been followed by the reader, and if he will study, in particular, Fig. 19 in which the composition of the production center process rates is exhibited, he will see how impossible it is to consider that the true process cost of each of these jobs is identical. Even if some of the details may be considered as open to criticism or even modification, there still remains a great gap between the cost of processes 1, 2, 3 and 4 and those concerned in the first job, namely, 10, 11, 15 and 20. It is perfectly obvious how and why the hourly burden plan gives an *average* cost, but it becomes a grave question of what possible use such an average cost can be except to mislead as to the actual and true cost of processing. In the absence of any better method, it is, no doubt, better than no cost at all, but that is the most that can be said for it.

Percentage on Wages Method.—In the foregoing examples it has not been thought worthwhile to make calculations of the cost of the two jobs on the percentage method, beyond that given in Fig. 6. It has already been stated in a former chapter that, of the two, the hourly burden method is sometimes the more accurate. But in this particular instance, a uniform rate of wages being assumed for all work, the percentage method would yield costs practically identical with those shown for hourly burden. All of the objections made to the one may be equally well made to the other, and, in addition, the percentage method has some which are peculiar to itself. Neither of them is free from the liability to give costs which are either much too high or much too low, depending upon the accidental combinations of production centers which may have been engaged on particular jobs.

Conclusion.—The substitution of process-hour rates under factory conditions for the rates derived from monthly rents, when each process was carried on as an independent business, has now been shown. Just as the former rents were necessarily dependent on forecasting and standardization, so the new process

rates are also standardized charges It follows, therefore, that some mechanism must be established to observe how far such standardization is accurate Further, the effect of short working time (idleness of machines) has not yet been fully considered These two important divisions of the subject will be dealt with in the ensuing chapter

CHAPTER VII

VERIFICATION OF PROCESS RATES CONSOLIDATED SHOPS

In the case of the independent producers no mechanism was necessary either to eliminate the effect of idle time or to control the accuracy of the hourly rates.

Having established an hourly rate representing the cost of manufacturing capacity for the working time, 200 hr. per month, it was merely a matter of mental arithmetic to calculate how much of this time had been wasted through idleness of the shop. If in shop 10 (see Fig. 13) only 180 hr. had been worked and 20 hr. wasted, the cost of the work actually done was obviously 180 × 30 (this shop having a rate of 30 cts. per hour). The amount so charged ($54.00) deducted from the total of monthly bills ($60.93) leaves $6.93, the value of wasted capacity. A calculation as simple as this does not require any elaborate records.

On the other hand, verification of the accuracy of the monthly rents is obviously no affair of the producer. But the landlord and the owner of the machinery would, of course, have to set up some such mechanism in order to observe that their figures were reasonably accurate and that the amount set aside for profit was being realized. Little has been said about this mechanism,[1] because, as a matter of fact, it would be closely similar to that to be described later in this chapter for the use of the consolidated business.

The Factory Burden Account.—Where standardized process rates are in use, the factory burden account is the place where the actual expenditure for the month, such as given in the monthly return (Fig. 2), meets the amount charged to production, that is, to jobs by means of process rates. This implies, of course, that all jobs and the charges to them for process rates are listed and summarized, but the method of doing this need not be considered here. Figure 22 presents a burden account in which the monthly total of overhead expense for the factory as summarized in Fig. 2

[1] See p. 50, Chap. V.

($1,757 48) is charged or debited, and against this on the credit side is placed the total of process rates charged to jobs As it is assumed that the shop has worked full time (200 hr), it will be clear that this amount must be that of the total of all process rates for the month, which, as may be seen from Fig 19 is $1,770 54

This latter figure is $13 06 *more* than the actual overhead as shown by the monthly return, consequently, a balance is carried forward corresponding to that amount Why there is such a balance and why it is on the left side of the account must now be considered

Burden Account		Month——————19—	
Actual Overhead Expense as Fig 2	$1,757 48	Standardized overhead charged to production through process rates (full-time production)	$1,770 54
Balance forward	13 06		
	$1,770 54		$1,770 54

FIG 22 —Burden account Consolidated shops

Actual and Standardized Overhead —It will be remembered that process rates were established on the basis of service factors which were standardized themselves on the basis of *annual* expenditure Consequently, it is not to be expected that the actual expenditure for any one month will coincide *precisely* with the standardized amount so allotted to each month Actual expenditure depends, obviously, on just what kind of repairs, etc , are in hand at the moment One month may see a general overhauling of buildings, another an overhauling of machines or of power equipment Even if this is not the case, a breakdown in one month may send up the overhead above the average, and, in fact, the expenditure of overhead is to a great degree controlled by accidental happenings, as regards any one month It is largely because these ups and downs in expenditure are reflected in current costs, with which they have nothing to do, what makes ordinary expense methods so unsatisfactory, apart from the fact that they do not truly gives individual process cost at all

Now, overhead, whether applied by means of percentages and hourly burdens or by the more exact method of process rates, is made up of two classes or divisions, the difference between them

being of great practical importance, namely, the "annual" and the "variable" charges. The annual charges are those which are *wholly annual* in character, such as interest, depreciation, salaries, etc., while the variable charges are those which are incurred for repairs, cleaning, laboring and other *current* happenings. The practical difference between these two classes of charge is that the former, once calculated, do not require monthly verification, while the latter need to be compared, month by month, with the standardized amount that has been charged into costs.

Mechanism for This Comparison.—Figure 23 shows the method of effecting this comparison. Each variable item is listed, class

Control of Variable Overhead Items Month———				
Item	Standard	Actual	Standard more than actual	Standard less than actual
Building repairs	$ 83 33	$ 50 00	$33 33	
Power repairs	15 00	12 00	3 00	
Power, fuel, etc	145 00	145 00		
Machinery repairs	35 56	65 00		$29 44
Office expense	20 00	14 00	6 00	
Cleaning	40 00	40 00		
Total	$338 89	$326 00	$42 33	$29 44
Net Standard more than actual Standard less than actual				$12 89

FIG. 23.—Comparison of certain variable overhead expense with standardized amounts.

by class, such as building repairs, machinery repairs, etc. The standardized charge for the month is set against each item. Then the actual expenditure for the month is also set against each item. In the additional columns differences are set out, namely, whether standardized charges are *more* or *less* than actual expenditure. Finally, the net difference between standardized and actual is taken out.

Significance of the Differences Found.—It is of considerable importance to understand just what these differences or balances signify. Taking the first, building repairs, it is found that $33 33 stands in the Standard More Than Actual column. This may

also be put another way, namely, that the actual expenditure on building repairs for the month is $33 33 *less* than that allowed for in the standardized charge, which has been transferred to jobs through process rates Power repairs and office expense have similar balances of $3 and $6, respectively

On the other hand, machinery repairs have $29 44 in the other column, and this case is an instance where the actual expenditure for the month has *exceeded*, by $29 44, the standardized amount charged through process rates

From what has been said above, the reasons underlying these discrepancies will be readily understood The amount not expended on building and power repairs, etc , this month will without doubt be expended in future months Similarly, although in this month machinery repairs have cost $29 44 more than was allowed for, it is to be expected that in other months the actual expenditure will be less than standardized and so make up for it

To ensure control of these variations, card ledger accounts are kept for each of the variable items, machinery repairs, etc , and the behavior of the balance or amount carried forward from month to month kept steadily in sight It follows that if a certain class of expenditure were to show a steadily rising discrepancy between actual and standard and if this were found on inquiry to be legitimate and unavoidable, then the question of revising the process rates affected would naturally arise

The net difference, when all variable items have been taken into account, is found to be $12 89 In other words, the actual expenditure on all items taken together is $12 89 *less* than that charged to jobs through process rates It will be noticed that this corresponds very closely with the balance carried forward in burden account (above) which was $13 04 The two amounts are, indeed, theoretically identical, but the small difference is due to the fact that (to avoid long decimal rates) the totals of service factors, as distributed by the schedule of process rates (Fig 19), do not *exactly* correspond with the totals as per schedules (Figs 18*a* to 18*f*) In some cases $2 or $3 discrepancy exists, and this explains why the two amounts just considered are not absolutely identical In this particular case the difference amounts only to 17 cts

Recapitulation of Process Rate Control —The method of process rate control may now be summarized as follows First, the expend-

iture is classified into service factors (corresponding in the main to the annual rents of the little independent shops as a whole), and this expenditure is standardized or budgeted Next, the share taken of each service by the production centers is determined and allotment made (This corresponds to the individual bills received by the little producers) A total amount for each production center is thus found, which represents the *annual cost of the manufacturing capacity of that production center* The next matter to settle is the normal number of working hours in the year, and this must be worked out with great care, allowance being made for all holidays and other usual interruptions to business Then the working hours for each month are worked out Owing to holidays, Sundays, etc , the working hours of one month will rarely be one-twelfth of the total for the year, although, for convenience, this has been assumed in the accounts hitherto discussed The annual cost of manufacturing capacity of one production center divided by the annual working hours gives the "process hour "

The figures worked out, it is an easy matter to tabulate the *standardized* cost of service factors for each month and to set against these the *actual* expenditure for the same class of items This enables a close watch to be kept on the accuracy of the service factors which are the keys to the accuracy of the whole costing process

Service Factor Control Is Subsidiary —The accounts which serve to compare the actual and standardized or budgeted charges to service factors do not form part of the official bookkeeping system They are merely to be regarded as measures of accuracy which point the way to modification of service factors and, therefore, of process rates when any determined discrepancy manifests itself

Burden Account Is the Official Account —While in the case considered above only one burden account for the whole plant has been presented (and in such a small plant only one would be required), in most cases the burden account would be *departmental* The service factors themselves would, first of all, be departmentalized, and the control accounts above described would then be departmental also Subdivision of this kind assists in maintaining accuracy, the scope or sphere of each service factor being narrowed to one department and, therefore, being more precisely determinable

There is no special manipulation of burden account necessary where process rates are in use Charges from the purchase or voucher journals, the cash journal and from the schedules of interest, depreciation, etc , are made in the usual way to the burden journal or journals Orders that have been worked on are listed and the total of all process rates is credited to burden account, just as, in the case of hourly burden, the amounts charged against each order for hourly burden are totaled and credited Any balance in the account is carried forward to the next month

Thus far we have assumed that all the production centers have worked full time We must now consider a case in which this is no longer true While the full working time of the concern remains 200 hr for the month, an instance in which some of production centers, for whatever reason, make less than 200 hr must be examined, and the influence of this on the burden account explained

Production Centers Working Less than Full Time —To avoid presenting a fresh set of accounts, only the *result* of this state of

Burden Account		Month——————19—	
Actual Overhead Expense as Fig 2	$1,757 48	Charged per process rates	$1,601 78
		Balance forward	155 70
	$1,757 48		$1,757 48

Fig 24 —Burden account Short-time working

affairs will be now given It maybe assumed that, on listing the orders worked on during the month, it was found that instead of the aggregated process rates amounting to $1,770 54, they amount only to $1,601 78, a shortage of $168 76 due to the fact (easily verifiable by other means) that production centers have not, in all cases, been kept full of work The question now arises What is the significance of this shortage and how is it to be dealt with? Figure 24 represents the burden account as it would appear under these conditions

The account is charged, as before, with $1,757 48, representing the actual expenditure on overhead for the month Against this is placed the $1,601 78 which was found on listing all the jobs worked on during the month This leaves a balance of $155 70, equivalent to unabsorbed burden or, in other words, the value of

wasted manufacturing capacity to be carried forward This balance is not the same as the shortage above referred to, namely, $168 76 The difference between the two amounts is $13 06

This difference of $13 06 will be recognized as the amount of balance which remained in the burden account when it had been credited with full-time process rates Now, however, it is swallowed up by the loss incurred by wasted manufacturing capacity, and, though it acts as a contra to the amount of this waste, it is, of course, no longer identifiable But it can, for the purpose of verifying the service factors as above explained, always be found by making up a burden account (Fig 22) credited with full-time process rates

Disposal of the Balance in Burden Account—The balance of $155 70 in burden account is on precisely the same footing as the $6 93 referred to on the first page of this chapter, as being the value of the wasted time in little shop 14 It represents the cost of manufacturing capacity that was not used Consequently, its ultimate destination, at the end of the financial period, is profit and loss account, since it is an item that must be met out of profits, if it is to be paid for at all

In percentage and hourly burden methods, a balance of this kind never appears in burden account, because on these methods there is no separation between utilized and wasted manufacturing capacity, but the cost of wasted capacity is added to that of utilized capacity and both are charged in one sum against jobs In other words, the true cost of jobs is *increased* by the amount of such waste, with the result that profit is thereby *diminished* to an equal extent In the end, therefore, all methods reach the same final, namely, that waste comes out of profit and loss The advantage of the process-hour method is that, while reaching the same ultimate result, wasted capacity is not allowed to get mixed up with true cost of jobs, but is separated from the beginning and carried to profit and loss account as a separate and clearly identifiable item

Gantt's Suggestion for Separation of Idle Time—After the publication of the writer's "Proper Distribution of the Expense Burden," in 1910, the question of the separation of idle time from time spent on jobs attracted general attention, and several suggestions were made for the modification of percentage and hourly burden methods so as to provide for this separation Probably the best is that made by the late H L Gantt which may be briefly outlined as follows

If, for example, in a certain shop the percentage of burden to direct wages is 75 per cent when direct wages are at a maximum, *i.e.*, when the shop is working full time, then, in the case of a lessened total of direct wages, the burden on this lessened amount shall be considered as 75 per cent, and the surplus charged as wasted capacity to profit and loss. A similar arrangement was proposed for hourly burden.

This proposal cannot be regarded as affording a solution of the overhead problem for two reasons. First, there is no attempt made to standardize the overhead. This being true, there will be fluctuations in the percentage even when the shop is working full time, since repairs and other items are not expended in even monthly sums, but, as has been shown, will sometimes be high and sometimes low without reference to what the shop is doing. This means that it will be difficult to determine the true percentage when the direct wages are at a maximum. It may be 75 per cent this month, but something else last or next month. It is true some kind of "average" might be struck, but this would not present so sound a basis as that provided by standardization of factors.

Further, the chief demerit of percentage and hourly burden methods is not at all removed by this proposal. The bearing of overhead on production remains as before. There is no discrimination between processes, so that, to take the example of the consolidated business of the original little shops, all the processes from 1 to 20 would be charged into cost at the same rate. This has been shown to be utterly discordant with the true facts of production.

Conclusion.—The subject of process rates *versus* percentages and hourly burdens has now been somewhat fully discussed on an elementary basis, which enables the principles involved to be clearly observed free of all extraneous considerations. Two important advantages stand out. One is the advantage of so dealing with overhead that, first, it is assembled in service factors, capable of independent control, and, second, the allotment of such factors to the different production centers in proportion to the use made of such services, thus giving rise to a process rate which is a true representation of the cost of manufacturing capacity. The second advantage is the separation, from the first and with no dependence on ratios or percentages, of the utilized capacity of each production center from the residual wasted capacity.

Properly regarded, it may be affirmed that a *clearer picture* of what cost signifies and of what it is composed is afforded by the process-rate method than by any other The standardized service factors themselves, with their close comparison with actual expenditure each month, give a budgeted control of overhead expense of the most intelligible kind Once these are set up, the idea that they are serving production centers in varying proportions wholly individual to each center becomes a familiar one and the connection between such services and process cost itself can be mentally followed without difficulty Finally, the idea that process cost is the cost of *capacity* to do work enables us to see that its non-utilization does not affect the cost of its capacity but is simply waste that must be met, not by arbitrarily and meaninglessly increasing the cost of work that was actually done but by charging off to profit and loss without permitting it to mix with true cost

As far as these pages are concerned, the subject of hourly burdens and percentages on wages is finished In no case do they give more accurate results than the service-factor and process-rate methods In the great majority of cases they give inaccurate results While the necessity of budgeting expenditure to provide a basis for service-factor calculations may be considered onerous by some, at least two reasons can be urged in its favor First, that budgeting forces an intimate acquaintance with every detail of the business, and in manufacturing it is mainly the details that spell success or failure Second, budgeting is being more and more adopted as a wise and necessary precaution, even where it is not being (as it should be) made the basis of the costing system

In Part II we shall take up the question of standardization and process rates in detail and shall examine their behavior under various special conditions It will be assumed that the reader is fully acquainted, at this stage, with the *nature* of a process rate Although in the examples given hitherto both the factors and the process rates are, so to speak, merely skeleton types, they are the more comprehensible on this account In Part III we shall consider what goes to the complete service factor and to the complete rate, but, as this implies merely a more microscopic examination of the detailed building up and as the complete rates behave precisely as the skeleton rates hitherto considered, acquaintance with the complete service factors and rates is better postponed until their behavior under varying conditions has been discussed

PART II

RELATIONS OF STANDARDIZED OVERHEAD WITH PRODUCTION

CHAPTER VIII

SOURCES OF PROFIT AND OF LOSS

In the preceding chapters forming Part I, the general idea of overhead *as service* has been developed Further, the usual vague character of overhead in relation to production has been replaced by the principle that not merely service in general but service of *very distinct and definite kinds* is implied These services (which when assembled and tabulated are called service factors) make up between them the total of all legitimate expenditure on production throughout the plant, with two exceptions These exceptions are expenditures on direct wages and on direct material, neither of which usually enters into overhead, although the former may do so under special circumstances which will be considered later

Supplementing the Outline —Up to the present, only a general outline of the fundamentals of the subject of overhead has been given The nature and working of service factors, process rates and the division into utilized and unutilized capacity has been briefly demonstrated in an elementary example This outline will now be supplemented by a more detailed examination into the relations of overhead and production, and particularly into the influence of standardization, which will form Part II of this work In Part III the practical steps in setting up a comprehensive system of service factors and process rates will be given in considerable detail

Sources of Profit and of Loss —The first subject calling for more detailed examination will be that of the influence of idleness on cost of production, whether such idleness is temporary or permanent It has already been shown that true cost is not

increased by reason of idleness of production centers, and what actually does happen, when processes are not worked to their full capacity as provided for by the service expenditure that has been set up, may now be considered in more detail

The Tool Point or Delivery Point —In every process carried on in a plant there is a tool point (as in the case of machine tools and similar machines) or a delivery point (as in the case of a vat, drying chamber, oven, winder, loom, etc ,) toward which material is passing and from which it will presently emerge

It is not even necessary that there should be a machine or anything equivalent to a machine in order to constitute a production center with a delivery point In hand industries the same principle is observable A cutting out bench, a sorting table or even an open floor area where sorting or assembling is being done may equally well be recognized as having a delivery point, on one side of which the operation is incomplete and on the other side complete, as far as that production center is concerned

Nor is it necessary that only one single operation shall be concerned The delivery point may come at the end of a number of separate but successive operations, provided that the flow of work is continuous, and that no one operation is conducted at a faster or slower rate than the rest A production center in such cases is the whole chain of operations, which is virtually one process and may, of course, be costed as such Such chains may be wholly mechanical (as in machines which perform successive processes on material within the machine itself) or may consist of a number of hand operations following one another in regular sequence and at a regular speed In the more primitive forms of the fish-curing industry, for example, a long table on trestles is set up on the shore, beside which stands a row of operators with knives, the fish being passed along from one to another, each cutting, splitting or removing some particular piece or part of the fish When the latter arrives at the end of the table, it is, naturally at the delivery point, and the whole affair,—table, trestles and the knives of the operators—forms one production center with one delivery point

Delivery Point the Only Earning Point —Now, in a plant of any kind wherein raw material is being worked on to form finished product, there is often a great variety of activity All sorts of duties are being performed Men are operating on material at production centers, repairing equipment, transporting

material from one production center to another, keeping costs, supervising and instructing, stoking boilers, watching pressure gages, inspecting work in process at various stages, cleaning floors or windows, making out production orders, controlling the flow of work and, in fact, *expending*[1] money in fifty different ways But the only way and the only place at which money is being *earned*, the only place at which all this activity focuses itself in reproducible value, is at the tool or delivery points of the various production centers This is so important a truth that it may be set out in the form of a basic principle, thus

There is no possible way by which manufacturing profit can be made save by work traveling toward and past the delivery points of production centers

This is equivalent to saying that profit is earned at the tool point or delivery point of processes and nowhere else

Effect of Cessation of Processing—This being the case, it follows necessarily that if and when work ceases to pass any particular delivery point, the making or earning of profit at this point also ceases In every possible circumstance this must be true, but it is also true that in most cases something more than this happens *Cessation of processing during normal working hours implies that actual loss commences* The few exceptions to this rule (and, theoretically at any rate, they are not even complete exceptions) may be considered first

Consider the case of the fish-curing process During one hour of this work so much wages have been expended, so many fish have passed up the table and have reached the delivery point and have given rise to potential earnings Now let us suppose that the supply of fish comes to a sudden and unexpected stop The operators are paid off and go home, the empty table remains What is the exact bearing on profit and loss of this condition of affairs?

In the first place it is manifest that profit-earning operations have ceased Material has ceased to move past the delivery point of the table On the other hand, as all direct wages have been cut off, there is no expenditure going on as regards that process, because any fixed charges due to the table are too trifling to take into account It might even be assumed that there was no table, and that the operations had been conducted on a natural platform or ledge of rock In this case the expenditure would

[1] Or being the recipients of expended money

absolutely have ceased, at least as regards that particular process

But in normal manufacturing operations the matter is not by any means so simple as this It is true that the work on an assembly floor or a sorting space approaches it as regards absence of expenditure when the direct labor is cut off It approaches but does not quite reach it, because, even though the operators have quit, the cost of space remains The fish process was established on free ground, but in a factory there is no free ground, consequently, even an empty space that is normally occupied by a process bears *some* overhead

Generally, however, it is not a question of empty space but of the idleness of perhaps costly equipment and the waste of services maintained for the purpose of making the process function, which services are not being called on, though their expense continues This aspect of the matter deserves some consideration

Cessation of Processing Implies Actual Loss —If the cessation of a process means that earnings have ceased and also that the cost of *processing capacity* continues, then it is evident that a leakage of actual money expenditure is taking place It may be asked, then, how in some cases it is possible practically to cut the loss on a process by simply ceasing to operate it, and in other cases actual loss is said to be set in motion by the stoppage of processing

The process cost of the fish process was wholly, or for all practical purposes wholly, made up of direct labor It was therefore possible, by one executive act, to stop entirely the *cost* of processing at the same moment that the *operation* of the process stopped But in the ordinary case of a factory process, all that the executive act can perform is to stop the expenditure of direct wages, and that is only part and sometimes only a small part of the total cost of processing

The cost of the services which furnish manufacturing capacity cannot be stopped or even diminished when one or even several processes cease temporarily to operate, even though direct labor on them is summarily laid off The labors of the firemen and engineers in the power plant will not be diminished, cleaners and laborers will still be drawing wages, repairing of equipment and buildings will not cease, transport men will not be laid off, supervisors and foremen will still be moving to and fro In fact, nothing of the usual activity of the plant will be lessened because

one or half-a-dozen of the production centers are idle, and material is ceasing to move past their delivery points

Yet this activity has no other reason for being kept in motion save to enable processing to be done at the idle production centers as well as at the others No executive act can pare this expenditure down a single cent because of that idleness It must, however, be obvious that some of this expenditure is having no useful result It is obvious that more activity is taking place than is essential, yet it is of such nature that it cannot be reduced It cannot be cut off summarily as can direct labor

Temporary and Permanent Idleness —If 25 per cent of the production centers were permanently taken out and the scale of operations of the factory thus diminished one-quarter, then a good deal of the overhead as represented by the various services would be curtailed Less fuel and fewer men in the power house, smaller expenditure on transportation of work in process, fewer foremen, a curtailed cost and production staff, less repair work on equipment—all of these items would necessarily and obviously be reduced if the processing were diminished *permanently* by 25 per cent

But on the other hand, if this cessation of processing were not a permanent matter but arose from shortage of work or bad management and instead of occurring at any one time or in any definite period (*e g* , in the case of a plant working only 4 days a week) the stoppage of processes were distributed during the day at odd times, two or three hours here and two or three hours there, with the net result that each machine had worked only 25 per cent of its full time, an altogether different situation would arise It is very questionable whether *any* possible saving or curtailment of the cost of running or, in other words, of the cost of manufacturing capacity could be made

In this case two entirely separate and distinct consequences would result from the idleness of production centers First, the *earnings* of the plant would be diminished 25 per cent During one-quarter of the working hours no material would be passing its allotted delivery points, and, consequently, only three-quarters of the *earning* capacity of the plant would be employed Second, an expenditure *against which there would be no earnings* would be going on amounting in total to one-quarter of the ordinary expenditure This would be a dead loss and, obviously, could be met only out of profits

The expenditure would thus be divisible naturally into two portions—one portion against which there were earnings to be set, another portion against which there were no earnings to be set, and this condition would continue until, one by one, the various production centers were restored to full work When all were working full time, then against every dollar of expenditure there would be assignable a dollar of processing, which is ultimately recovered through the selling price of the articles manufactured

The Process Dollar —In a plant or shop which is nominally working full time, the total expenditure on overhead per hour may be regarded as passing into product, dollar by dollar, as such product passes the delivery points of the production centers But as overhead is only a collective name for separate services to production centers maintained to keep them in full capacity for doing processing, then it follows that every such dollar carries a varying proportion of each service (individual to each production center), so much for machine depreciation, interest and repairs, so much for space factor, so much for the cost of supervision, etc

If now material ceases to pass any delivery point, that is, if any particular production center becomes idle, we may picture the process dollar dripping, as it were, uselessly from the delivery point, thus wasting so much supervision, so much cost of maintaining space and machinery and so much of the other service factors concerned

The process dollar represents the cost of manufacturing capacity of the particular process being discussed, and at any time it is either being incorporated into processed material or, alternatively, is running to waste In the latter case there is no possible chance of its being recovered in the price of any item of product, since no product is being worked on If it cannot be paid for by the sale price of product, it must be paid for out of the accumulated profits of the business, that is, it must be charged, like any other unfortunate occurrence, to profit and loss account

Figure 25 shows in diagram form the utilization and wastage of the process dollar Into the funnel, which represents a production center, service cost of various kinds (factors) is being discharged in a series of steady streams In the funnel these lose their identity and are merged into a single mixture (process rate) which, in its turn, is being discharged through the spout at every moment during the working day The spout may be considered to represent the delivery point of a production center

Past this delivery point jobs are moving, and these jobs take up or absorb the flow in proportion to the time taken in passing the delivery point (process time) When no job is passing through, then the flow falls to waste The diagram pictures the third hour of the working day One 2-hr and one 1-hr job have passed through and have consequently taken up 3 hr flow of service cost At the moment pictured no job is actually passing and the spout is, therefore, discharging to the floor uselessly

Rivulets of Profit and of Loss —In a shop containing a number of production centers, some of which are working on material and some are idle, the situation may be pictured as affording a number of rivulets of earnings trickling from the delivery points of the centers at work, and also a number of rivulets of loss proceeding from the delivery points of those which are lying idle The moment that the process dollar ceases to drip into work, it drips into the accumulating pool of waste, that is, actual out-of-pocket loss All kinds of services are running to waste at every idle delivery point, just as surely as a mixture of valuable chemicals runs to waste when the spigot of its container is carelessly left open

Idleness of production centers is a far more serious matter than a mere temporary *cessation* of earning power The slogan "keep machines at work" acquires new force if the true consequences of idle delivery points are clearly understood

Conclusion —The prime division of all expenditure on production is into two divergent classes (1) expenditure that has been utilized for the purpose it was expended, namely, to manufacture product, and (2) expenditure that has not been so utilized but which has been wasted owing to the idleness of certain delivery points

In any plant there is a large number of places at which money is being *expended* either for direct production or for indirect services to production, but only a comparatively few places where money is being *earned*, namely, those delivery points past which at any given moment product is *actually passing*

As all legitimate expenditure on overhead, that is, on services, is for the purpose of maintaining delivery points in a condition to process product, it follows that when such delivery points are working 100 per cent of full working hours, then all overhead (service) will be passing into jobs as part of their cost But should any delivery point cease to work, then the above-mentioned

expenditure on overhead is being expended to no purpose, as far as that delivery point is concerned, and is becoming an out-of-pocket loss

Every process dollar thus wasted is made up of fractions of each kind of service which normally are required to enable the process to function, and this process dollar may be pictured as falling into the pool of waste which collects all unutilized expenditure on service The contents of this pool of waste must ultimately be charged against profit and loss and not allowed to become mingled in any way with true cost of production

CHAPTER IX

VARIABLES CONTROLLING COST REDUCTION

In the preceding chapter it was demonstrated that while the expenditure for maintaining the plant in a condition of preparedness to do process work proceeds in a steady flow, hour by hour, it does not follow that all this expenditure is utilized or that work is actually done with it Some of it fails to be employed usefully and may be said to drip into a pool of waste instead of becoming connected with product in the form of legitimate process cost

We have now to consider that portion of this expenditure which is not wasted, but which, on the contrary, flows through an active delivery point to jobs In this connection it will be convenient to include in the inquiry not only the cost of services (overhead) as expressed in a process rate but also the cost of direct wages which are expended on the job

Three Variables —When the total cost of a job is analyzed, it is found that three distinct elements enter into it, *any one of which can be varied independently* These are

1 Time,

2 The direct-wage rate,

3 The process rate

In considering a possible reduction in the cost of a job, the following conditions will be found to control the situation

1 *Time of processing* being held constant, reduction may be effected in the process rate, or in the direct-wage rate or in both

2 *Direct-wage rate* being held constant, reduction may be effected in the process rate, or in the time of processing or in both

3 *Process rate* being held constant, reduction may be effected in the direct-wage rate, or in the time of processing or in both

In setting about the reduction of a job cost it may be asked, therefore, first, whether the *time* of operation can be reduced, next, whether the work can be done by a lower rated operator, and, third, whether it is possible to reduce the process rate itself

The number of answers to the problem does not end here It may be asked, further Will the employment of a higher rated operator lead to sufficient reduction in time of operation to justify the extra wage rate?

Similarly, it may be asked whether by altering the machine (which alteration involves an increase in the process rate and a reduced time of operation) a net gain will result

Reduction of Time of Operation —If it is possible to reduce (by means of time and motion study or otherwise) the time which is taken by the job to pass the delivery point of the process, then the maximum of benefit is attained The gain will be of three kinds, namely,

Less direct wages will attach to the job

Less process cost will attach to the job

Both the man and the machine will be freed to do other work This is equivalent to an increase in manufacturing capacity without extra cost

This may be studied in Fig 25 by imagining the belt carrying the jobs to proceed more quickly past the delivery point As the drip of process-rate cost is uniform during the working period, it is evident that each job will get a less charge of it, or, in other words, process cost will be reduced And as direct-wage cost runs also by the hour, that will be reduced in like proportion

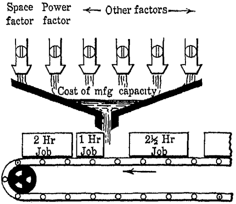


Fig 25

Reduction May Be Neutralized —From an inspection of Fig 25 it will be inferred that the possibility of *retaining* the advantage which quicker process time gives is dependent on

keeping up a flow of work past the delivery point If, for example, in an 8-hr day we have a series of jobs that each take 1 hr to process and if by improved methods of handling we cut 15 min off each job, a total saving of 8 × 15 = 2 hr will be effected But unless we have at hand jobs which will utilize the 120 min thus saved, it is evident that the drip will fall into the pool of waste This waste may be sufficient to neutralize the gain due to time reduction on the jobs, or at any rate to diminish it considerably The following example will show how this neutralization takes place

Process rate	$1 per hour
Wage rate	0 40 per hour
Original time of operation, 8 pieces at 1 hr each	
Reduced time of operation, 8 pieces at 45 min (0 75 hr) each	

ORIGINAL OPERATION SPEED		REDUCED OPERATION SPEED	
Process cost, 8 × 1 × $1	$8 00	Process cost, 8 × 0 75 × $1	$6 00
Wage cost, 8 × 1 × $0 40	3 20	Wage cost, 8 × 0 75 × $0 40	2 40
	$11 20		$8 40
Cost, each	$ 1 40	Cost, each	$1 05
No wasted capacity		Idle time, 2 hr at $1	$2

The net result of the changes effected in processing time are seen to have resulted in a reduced cost of 35 cts per piece, namely, from $1 40 to $1 05 per piece *This new cost* ($1 05) *is the correct and official cost of the job henceforth,* since it has been done in the time specified, and it may be assumed that it can be done in similar time on a future occasion As far as the individual job is concerned, therefore, there has been a drastic and permanent reduction But as far as *this occasion* goes, the net gain of $2 80 ($11 20 − $8 40) is largely neutralized from the viewpoint of ultimate profit by a waste amounting to $2 due to the fact that the 2 hr saved on the processing were not utilized for fresh production, but the delivery point was idle for those 2 hr

The saving made on cost of the jobs has been largely lost by failure to utilize the time so freed for more work This loss does not fall on the jobs themselves but on the business as a whole, because it represents an inefficiency Of course the ultimate position will be that while profit and loss account will benefit by an additional profit on the job of $2 80, there will be an offset of $2 on the other side due to this failure to keep the machine 100 per cent busy

It is assumed, in the foregoing, that the operator was laid off, as could be done, but if this were not the case and he were idling about waiting for work, then there would be an additional 2 hr. at 40 cts. an hour to be charged up as waste. This would altogether wipe out the saving on the jobs.

Reduction of Direct-wage Rate.—If, without increasing the time of operation (and, of course, without prejudicing the quality of the work), an operator at a lower wage rate can be employed, it does not require any demonstration that the cost of the job will be reduced. But, in fact, this simply amounts to a discovery that hitherto a needlessly high-rated operator has been assigned to the work.

On the other hand the assignment of a lower rated operator may result in an increased time of operation, and it then becomes a question whether there is a net gain in the transaction. As a general principle, anything that tends to increase an operation time is to be avoided, since this is equivalent to diminishing the total capacity of production. Under special circumstances, and particularly when there was difficulty in maintaining full work for the production centers, a net gain may result, provided that the process rate is lower than the operator's wage rate and that the increase of time is very small. The narrow margin that exists may be gathered from the following example:

Process rate, 20 *cts.* *Operator's rate,* 40 *cts.* *Time,* 1 *hr.* *Job cost,* 60 *cts.*

Now, if the operator's rate becomes 35 cts. and the time of operation is increased to 1.1 hr., the figures will be:

Process cost, 22 *cts.* *Wage cost,* 38½ *cts.* *Job cost,* 60½ *cts.*

Though the process rate is only one-half the wage rate and the time increase in only 1.0 : 1.1, there has been a small loss on the job. Any higher process rate would increase this loss, consequently, it will be seen that we are here in a region of no great possibilities. It may be said, in general, that increase in time of operation can be justified by lower wage rate in only exceptional circumstances.

Increase of Direct-wage Rate.—A more interesting problem is that of the assignment of an operator at a higher wage rate to the job, with the result that his superior skill or application leads to a *reduction* in time of processing. This is equivalent to saying that more direct wages but less process rate will be attached to the job. Obviously, the possible gain will depend

entirely upon the relative values of the increased wage and decreased process cost

The higher the process rate relative to the wage rate the more certain is the gain, as is shown by the following example

Time, 60 *min* *Wage rate*, $0 40 *Process rate*, $1 *Cost of job*, $1 40

Now, we may suppose that an operator at 50 cts an hour is assigned to the job If he does not save *any* time, the cost of the job will be increased by the additional amount of rate, namely, 10 cts It will now be $1 50 To break even with the lower rated man, therefore, the combined wage and process rates must be reduced 10 cts by reducing the time of operation

The wage rate being 50 cts and the process rate $1, the combined rate will be $1 50, which is 2½ cts per minute The new operator must, therefore, reduce operating time by 4 min to break even with the old operator, and any reduction beyond this will be gain, thus

Minutes	Rate	Cost
60	$1 50	$1 50
59	"	1 47
58	"	1 45
57	"	1 42
56	"	1 40
55	"	1 37
50	"	1 25

Next, it may be supposed that higher process rates are in question This implies that smaller time savings will suffice to break even, thus

Time, 60 *min* *Wage rate*, 40 *cts* *Process rate*, $2 *Job cost*, $2 40

With an increased wage rate of 50 cts , as before, the new combined amount will be $2 50 per hour, or 4 17 cts per minute To save 10 cts will, therefore, require only 2 4 in place of 4 min

With a process rate of $2 50, the combination will be $3 per hour or 5 cts per minute Only 2 min reduction of process time will, therefore, suffice to break even

With a $3 process rate, only 1 8 min will be required to break even

Higher Cost with Reduced Operation Time —In all of these cases there is a certain point at which the new and the old rates will break even, and beyond this point saving in the cost of the job will be secured It must not be overlooked, however, that

any reduction whatever in the time of operation means that more work is passing the delivery point throughout the working day This is equivalent to a larger capacity for production, or, rather, to a liberation of productive capacity

This larger capacity for production would show on individual jobs as reduced *process* cost, and does so, but, in the cases just considered, this reduction is masked by the increase in direct wages *It is possible, therefore, for a larger volume of production to be accompanied by an increased cost per job*, a paradox that is not understandable on the face of it The following example exhibits this paradox

To begin with, we have a process rate of $1 and an operator at 40 cts who does a certain job in 48 min

Time, 48 *min* *Wages*, 32 *cts* *Process cost*, 80 *cts* *Total*, $1 12

Next, a second man is substituted for the first at a wage rate of 60 cts If he does the work in the same time the result is

Time, 48 *min* *Wages*, 48 *cts* *Process cost*, 80 *cts* *Total*, $1 28

Here there has been a loss on the change of operators, because the higher wage rate has not led to more production But if he succeeds in reducing the time to 43 6 min the result is

Time, 43 6 *min* *Wages*, 43 6 *cts* *Process cost*, 72 6 *cents* *Total*, $1 16

The result of this reduction of time is that

1 The cost per piece has *increased* from $1 12 to $1 16

2 The output per 8-hr day has *increased* from 10 to 11 pieces

If attention is centered on the process rate, the paradoxical character of this result disappears In the first case 10 pieces are produced for a total of $8 process-rate cost In the second case 11 pieces are done for the *same* process cost Process cost has, therefore, been reduced But in the effort to bring about this desirable result, so much direct wages have been expended that the larger output costs 4 cts per piece more than the original output

Effect on Profits—Under some circumstances this result might be quite acceptable Although the cost per piece has been slightly increased, the effect of the greater output is to give a larger amount of profit per day

If it is assumed that the articles thus produced have a selling price of $2 each, then (not taking into account any question of selling expense) the relative profits on a day's output will be

	First Operator	Second Operator
Sale price	$2 00	$2 00
Cost price	1 12	1 16
Profit	$0 88	$0 84
10 pieces @ 88 cts		$8 80
11 pieces @ 84 cts		$9 24

The profit on the day's output is 44 cts more with the second operator and higher unit cost than with the first operator at the lower wage rate

In times of brisk business with considerable pressure of unexecuted orders, the higher price per piece might be considered as well compensated by the larger output and the quicker turnover of a smaller profit

Influence of High and Low Process Rates —It will be obvious that the result of applying a higher wage rate to secure a reduced process rate cost will depend entirely on the relative sizes of the two rates (direct wage and process) The higher the process rate the less is the masking influence of the higher wage rate on the ultimate cost per piece If, in the above example, the process rate had been $2 instead of $1, there would have been nothing paradoxical about the result It would have been a clear gain on all counts, thus

Original operator, 48 min @ 40 cts Wages, 32 cts Process rate, $1 60 Cost, $1 92

Second operator, 43 6 min @ 60 cts Wages, 43 cts Process rate, $1 45 Cost $1 88

In this case the cost per piece is *lower* notwithstanding the high-wage rate, and the additional advantage of an output increased from 10 to 11 pieces per day is also secured

Variation in Process Rate —To *reduce* a process rate is a much more difficult matter than to reduce time or wages, since it can be done only by lessening the call on service factors, which is generally impossible

The only way in which a lower process rate can be applied to a job is (1) by doing it on a machine or production center with a lower rate, if that is possible, or (2) by some fundamental alteration of the machine itself so that it consumes less power, or occupies less space, and is so changed in demand on service that virtually a new machine with a new process rate results This, however, is practically reverting to condition 1 Except by discovery of an error in calculation, it is extremely difficult

to imagine any condition under which reduction of an individual process rate could be justified, once it is regularly fixed

It is true that the cost of an *entire service factor* might be lowered, but such a change would affect all the production center process rates in the whole plant or department If, for example, a new and more advantageous contract for electric current were to be concluded, that would reduce the power factor and, therefore, the individual process rates in proportion as power entered into their composition But no lowering of one rate by itself, out of proportion to others, would occur

Effect of New Process—One of the advantages of the process-rate method of costing is that it focuses attention on process cost as apart from time reduction and direct-wage reduction If in a given job the process cost is $17 and direct-wage cost $12, and if the speeding up of the process work has been carried as far as possible, then the only hope of further cost reduction is by substituting a process, or processes, of lower rate But this will usually imply the substitution of a new machine, or machines to do the work On the other hand it may be possible to design a new machine which will have a much *higher* process rates but which will do the work faster, or will either dispense with direct labor or enable a lower priced operator to be employed on the work In either case a machine of new design is implied

It then becomes an interesting question to to know how far it will pay to substitute a machine of new design and capacity for the one in use When process rates are in use, this can be calculated with considerable exactitude If the new design (while performing the process no slower than before) occupies less space, takes less power and is less costly in itself, then no question can arise whether or not it would be advantageous to adopt it, because, under those circumstances, it is evident that its process rate would be smaller than the one in use

But if the new design provided for a machine of larger capital value, occupying greater space, taking more power and having possibly a larger repair factor, but working either at much greater speed or much more automatically (replacing *skilled* labor), then the propriety of its adoption would not be self-evident but would depend upon figures

Effect of Machine Substitution—The well-recognized tendency at the present day to substitute machines of more or less automatic character for skilled labor (or at least to eliminate

the skilled portion of a job by mechanical means so that a less costly grade of labor is required) makes it more than ever essential that process cost should be established on some much more accurate basis than by percentages or hourly burdens *The process dollar tends, in fact, to become more important every day than the direct-wage dollar*, but whether this tendency has any natural limitations has not been much discussed

It would seem that in any particular case the advisability of substituting machinery for direct labor must depend largely upon whether the former can be kept steadily at work In an industry with an intermittent demand there is this difference between the process dollar and the direct-wage dollar, that the latter can be cut off when conditions demand, but much of the former continues to trickle into a pool of waste whenever operations are curtailed and however severely expenses are pruned This aspect of the matter, though important, is somewhat outside the scope of the present inquiry, but some attention may be given to considering the relations of the process dollar and the wage dollar when substitution of a process with a high process rate is made for one of lower rate It is, of course, implied that certain advantages are obtained by the substitution and how far these are realized in the cost of the product is the important point

Higher Process Rate with Increased Output—It may be assumed that a machine with a process rate of \$1 an hour is operated by a man at 80 cts, and that the maximum output found to be possible is 45 min per piece, thus giving process rate per piece, 75 cts, wages per piece, 60 cts, Total, \$1 35 Now, by alteration of the machine, or by substitution of a new machine, the process rate rises to \$1 50 an hour but the time per piece falls to 30 min Cost of the job will be 75 cts process rate, 40 cts wages, total \$1 15 This, of course, justifies the substitution But if the substituted machine had a process rate of \$2 instead of \$1 50, then the figures would be process rate, \$1, wages 40 cts, total \$1 40, which is a higher cost than the original machine gave

On the other hand, if in addition to reducing the time of operation from 45 to 30 min, the new machine also allowed a less costly type of labor to be employed, say at 46 cts an hour instead of 80 cts—it being understood that under the new conditions the skilled part of the process has been transferred to the machine

and therefore no additional output can be obtained by a skilled man—then the figures for a 30-min. operation would work out as process rate, $1, wages 23 cts., total $1.23. This would be less than the original cost and would probably be considered as justifying the substitution.

Effect of Idleness Magnified.—It must not be overlooked that the necessity for keeping the machine at work 100 per cent of its allotted time is now very much greater than was the case with the original machine. If the original machine stood idle, the process dollar was leaking into the pool of waste at the rate of $1 an hour. Now, however, it is double this. Every idle hour is costing $2. Moreover, the maximum saving possible under exceedingly short-time conditions might be considerably less for the new machine, if the higher rate were largely made up of space factor and individual machine factor, both being items of relatively large capital outlay. If, on the contrary, the power factor was much higher in the second case than in the first, then greater economies might be effected under very short-time conditions.

Possibility of Calculating Results.—While no simple formula can be deduced from these considerations, the possibility of calculating in advance the effect of substituting a new machine for an existing one is an important instrument in the hands of the production engineer. The service factors of a department or shop being known, it is no difficult matter to calculate in advance the process rate which would be allotted to the new machine. Then if the output of the latter can also be forecasted, no further elements of cost of the new process remain unknown, and it can be calculated with considerable precision. Add to this the wage rate which the degree of skill required for the new machine calls for, and all the details of job cost are ascertained.

Machine Not Fully Employed.—It might happen that in designing a new machine for a particular class of work, the output would be so accelerated that not more than, say, 75 per cent of the normal working time could possibly be utilized. That is to say, that in 75 per cent of the normal working hours the new machine would turn out all the parts required to keep ahead of other parts used in combination. The calculation of a process rate under these circumstances does not proceed on the ordinary lines, since the 25 per cent of idleness is foreseen and intentional. The fixing of process rates under such conditions will be dealt with in a later chapter.

Conclusion —From what has been treated of in this chapter the following deductions can be made

1 The three elements of a cost, namely, time, wage rate and process rate, can be varied independently

2 Reduced time of operation, without increase in the other elements, is the clearest case of gain Cost is reduced and capacity for production liberated

3 This gain may be neutralized if the time so saved is not utilized for more work

4 Substitution of a lower rated operator leading to increased time of processing may give a small gain if process rate is relatively low, but there is also a loss of manufacturing capacity to counterbalance such gain

5 If an operator at higher wage rate can decrease the time of operation, the net result on the cost of the job will depend on the relative amounts of the wage rate and the process rate The higher the latter the larger the chances of a net gain, but in all cases of this kind a liberation of manufacturing capacity occurs In certain cases an increased cost of job may follow an increased output The results under given conditions can easily be calculated in advance

6 It is impossible, in general, to reduce a process rate individually without making such alterations to the process that the result is virtually a new machine

7 A new machine with a higher process rate may cheapen production if (*a*) it reduces time of processing sufficiently, or (*b*) if it permits of a lower rate of direct labor, or (*c*) both of these together

CHAPTER X

STANDARDIZATION

I OF TIME AND DIRECT-WAGE COST

Time being a very important variable of cost, a great deal of attention has been given to methods of ascertaining the reasonable or proper time that should be consumed in performing a given operation or process These methods, known as time and motion study, are entirely outside the scope of this work, but a discussion of the end at which they aim is perhaps an advisable digression at this stage of our inquiry

Time and Motion Study—The prime aim of time and motion study is to determine the practicable minimum time in which an operation may be performed But in some industries, at least, this also involves a study of the question What degree of skill is involved in the operation? This latter question is answered in terms of a wage rate, so that the combination of a "standard" time with a "standard" wage rate gives rise to a standard, or what is frequently termed a "predetermined" cost

Predetermined Cost—This popular term, like many other popular terms, is a misnomer, or rather it is a double misnomer, failing to fulfil its promise in two directions In the first place, as usually employed, it deals only with the direct-wage cost of product, leaving the very important matter of overhead to be attached to each job on one of the old inaccurate methods In the second place this predetermined cost is not a cost at all The only sense in which the word "cost" can be applied accurately is in the sense of something that has happened The cost of a thing is what has been expended on it, and not a guess or estimate, however accurate the basis, as to what it will or ought to cost

This objection is not merely a hypercritical one, since a false impression of the scope and value of so-called "predetermined" costs frequently arises from the use of this term to describe a procedure which is, after all, only a method of forecasting results On the other hand the term "standardized" may be used in place of "predetermined" and this very fairly corresponds with

the fact, namely, that a standard of attainment has been set up, a goal which it appears there should be no difficulty in reaching But even then it would be better to speak of *standardized direct cost* and not merely standard cost when, as is usually the case, the overhead to be connected therewith is not itself standardized

Accuracy of Standardization —In ordinary circumstances standardization depends upon the possibility of building up a rate, or a time, or a cost out of a considerable number of small elements, the values of which are already known with some precision This aggregation of infinitesimals will generally be a close approximation to the truth, even though some of the items may be more or less incorrect, depending, of course, on the relative dimension and number of the small items themselves relative to the total thus predetermined

Under the most favorable conditions, a high degree of accuracy in forecasting or standardizing the time element in cost can profitably be realized But such conditions are not to be found everywhere or in all industries, or even in all shops of the same industry The most exact results are obtainable in those cases where time and motion study can be applied to the machines and the various items of product Such detailed studies, however, are costly and can be economically applied only where production itself is highly standardized, that is, where the same processes on the same materials are carried out day after day and month after month Good results are also obtainable in those industries wherein processes are not variable in speed, or are only so variable when working on definite and well-understood varieties of material *i e*, one speed for each kind of material

Machine-shop Conditions —Machine tools differ from almost all other processing machinery in that they are universal tools capable of doing a large variety of work at a large variety of speeds on a large variety of materials In many industries no condition of this kind exists, machines can perform one operation only and very often at only one speed

Moreover, all the great variety of machine tools exists in order to perform much the same kind of operation, namely, the removal of chips, and the selection of a tool for a given job is frequently a matter of choice rather than of necessity Planers, shapers, routers, profiling machines, slotters, nibbling machines and milling machines all act in much the same way, while lathes and drills and boring machines are also in some cases interchangeable

Further, these machines may be applied to cast iron, mild steel, brass, copper and other metals, to compositions and, some of them, to materials like ivory and hardwoods

Under these circumstances, the proper course of processing a job is by no means a simple matter to determine Which type of machine shall be used requires consideration, the problem of chucking or holding the work, the use of jigs and templets and other auxiliary appliances must be worked out, the nature of the material considered with reference to the speed of working and to the composition of the cutting point, and sundry other minor matters determined before the job gets to a machine at all

The complex circumstances surrounding each job make the need for a careful survey of the procedure imperative There are so many opportunities to do not necessarily the wrong thing but certainly the thing which is not the best and most efficient Out of four or five possible alternative ways of doing the work, only two may perhaps be really inefficient and the others more closely alike, but the selection of the most efficient can very often be ascertained only after considerable study and with the aid of first-class experience

Conditions like these are not found at all in the majority of industries Elaborate methods of studying the capacities of machines and the peculiarities of materials, complex systems of production control and detailed analysis of time and motion on individual jobs, though essential to machine shops, are out of place in industries where these conditions do not exist

Time Studies and Cost Records—Time and motion studies are used to attain two ends First, the elimination of unnecessary details of operation and the reduction of movements to the minimum necessary, and, second, to set up a datum or standardized time which shall represent the normal or proper time of processing the job on the particular machine being studied The latter is, of course, simply derived from the former and is the only matter with which, from the costing viewpoint, we are concerned

If, for example, after a time and motion study of a certain job, it is found that it takes 10 min when all possible simplification of motion and all possible speeding up of the machine have been effected, then 10 min is the predetermined or standard operation time for that job Next, the question of the direct-wage rate appropriate to the job has to be settled Let it be supposed

that this is 48 cts an hour, then the predetermined cost of that job is said to be 8 cts, *without taking overhead into account* Predetermined costs are therefore, as pointed out above, nothing but a forecast, presumably made on a very accurate basis, of the *time* which should be taken to do the job, and with this is associated a preindication of the *rate of wages* properly payable for the class of work involved They have no relation to the important question of overhead expense or burden, which is left to be added on any of the various possible methods

In other types of industry, wherein machines work at a fixed speed, though some improvement may sometimes be effected by time and motion study in respect to the feeding and removal of materials, reliance will, in general, be placed on records of previous work on the job, if these have been taken out over a considerable period with precautions to secure reasonable accuracy Inspection of such records will enable a fairly accurate standard or normal time of operation to be fixed, which will take the place of the standardized time obtained by time and motion study in more complex industries

Essential Feature Is a Datum —In using the above-mentioned predetermined or standardized costs, their chief value lies in the *comparisons* that it is possible to set up between such costs and the actual time and wages consumed on each repetition of the job Then any failure to perform the job within the standard time or by means of the assigned rate of wages is considered as inefficiency, which may be expressed as a percentage Thus, if we have a series of jobs in a given period with a total standardized or predetermined time allowance of 150 hr at a wage rate of 48 cts, then the total predetermined cost of these jobs (neglecting overhead) will be $72 But if actually 162 hr at the same wage rate were taken, this would amount to $77 76, or $5 76 more than standard The ratio of standard to actual cost would be as 100 108

It will probably have already been inferred by the reader that the really essential matter in standardized costs of this character is the setting up of a datum which is regarded as 100 per cent of efficiency *This is an altogether separate affair from the calculation or predetermination of such a datum* In other words the datum, so many hours at such a rate of wages, is one thing, and the means by which this datum is arrived at quite another If it is arrived at by time and motion study, it is probably

quite close to accuracy If set on the evidence of carefully kept cost accounts, it will represent the standard practice of the shop, though this does not by any means imply that it cannot be improved If set by judgment of a foreman or rate setter, a third grade of accuracy is reached But however set, the use of it remains the same, namely, as a convenient datum to which future repetitions of the job may be referred and compared

Use of Datum as Standard Efficiency Ratios—If, then, we have assigned to all the jobs on which it is expected to work during the month a standard time and wage rate (that is, a standard direct cost), on some basis that appears satisfactory, it is open to a comparison on the following lines

Standard time and wages on completed jobs, 460 hr	$202 50
Actual time and wages on same jobs, 506 hr	222 75
Ratio of efficiency, standard to actual	100 110

This is equivalent to the statement that costs have come out 10 per cent above expectation

Failure to reach standard may, however, arise from two causes *First*, the failure to perform the job in the standard time or, alternatively, failure to turn out as many pieces in a given time, which is the same thing put another way *Second*, the direct labor engaged on the job may have been rated at a higher rate than allowed for by standard In the above example, the ratio of hours (460 506) is the same as that of wages ($202 50 $222 75), namely, 100 110 in each case But if it be assumed that the actual time and wages were as follows

Actual time	506 hr
Actual wages	$232 87

then the ratios will be

Standard time to actual time	100 110
Standard wages to actual wages	100 115

Significance of These Ratios—The ratios thus calculated point to one of three conditions (1) standards were wrong, or (2) in the case of time, loss of efficiency has taken place, or (3) in the case of wages, there has been either a loss of efficiency or wage rates for the class of work have gone up

If the product under discussion were uniform, that is, if it were a question of a shop turning out precisely the same product day after day, these figures might be sufficient to indicate the

cause of the discrepancy with very little further search, but if, on the contrary, a number of different jobs had been included in the total, then this blanket ratio would need analysis to detect *where* the discrepancy lay On further inquiry it might be found that while many of the jobs were turned out in close agreement with standard, others were way off, thus localizing the cause of the trouble For the only use of such ratios is to indicate the place and amount of departures from standard as a guide to the future

Revision of Standard —If any element of direct cost is found, in actual practice, to be no longer identical with its corresponding item in the standard cost, then the latter should be altered and a new and revised standard set up Thus, for example, the wage rate applicable to the job may have permanently risen or fallen, or some new auxiliary appliance (jig, chuck, feeding device, etc) may have been introduced, giving rise to a shorter processing time Or, especially if the standard time has not been based on time and motion study, the assigned time of operation may prove to be unrealizable in practice In all of these cases a new and revised standard is called for

Value of Standardized Direct Costs —It may be asked of what value a standard cost is when it is obviously open to revisions of this kind and, in the nature of things, must tend, at any rate eventually, to approach and coincide with actual cost by reason of repeated revisions The answer is that, so long as it is not made into a fetish, standard cost is a valuable device, because it provided a datum, departures from which can be so tabulated that they reveal the cause of inefficiency *by classes*

In the case of direct-wage costs, these classes are only two Either the job has been done in a different *time* from that allowed in standard, or an operator at a different *wage rate* has been employed It is quite valuable to be able to distinguish between these two classes of discrepancy, and the more reliance is placed in the standard (due either to its having been based on careful time and motion study or on repeated revision in the light of past performance) the more valuable this power becomes

Effect of Piecework or Premium —It must be remembered, however, that in some industries, wherein the speed of operation is not limited by machines, and in those cases wherein the subsidiary operations (*e g* , getting machines ready, fixing tools, jigs, etc , and feeding material) bear a considerable proportion to the actual operation time, a variable element is introduced

depending very largely on the operator. In such cases, payment by piecework or one of its equivalents is common practice, and this implies a frequent variation in the operation *time* of the job. Thus 100 pieces at a piecework price of 45 cts. each will always coincide with standard wages, namely $45 per 100, but the time of operation will vary in proportion to the rate of earnings of the operator, being different probably on each occasion of the job passing through the shops.

Where premium systems are in use, wherein savings from a time allowance are paid for, then both time and wages may vary from one passage through the shop to the next.

Effect of Bonus Payments.—In certain cases, particularly where product can be reckoned in some convenient unit such as yards or pounds, a bonus may be offered to a shop collectively, based on the number of yards or pounds produced during the month above a certain fixed datum. This is a separate and *additional* matter to the standard time and wage fixed for each individual job. As regards any individual job or set of jobs, the share of this bonus will naturally be a variable quantity.

Standardization of Piecework, Bonus, Etc.—While it is possible to assign fixed hours and amounts to standard costs in respect of piecework, premium and bonus payments, there seems but little utility in so doing, inasmuch as each of these methods carries its own measure of efficiency. The direct-wage amount in piecework and the hours allowed in premium will be always standard, but as regards bonus there is little connection between individual jobs and the resulting efficiency except arithmetically. In what follows, therefore, it is assumed that daywork is in question, and reference to the influence of these three methods of payment on the cost is omitted until later.

Simplified Method. The Averaging of Detail Costs.—The possibility of expressing actual cost as a ratio to standard cost has given rise to simplified methods of cost keeping which must be referred to here.

If in the case cited above (p. 108) it were assumed that the 506 hr. and $222.75 direct wages were spread over 50 completed jobs, by the method now to be described it is possible to get some idea of the cost of individual jobs *without taking out this cost in detail.*

The principle involved depends on an argument something like this: If a number of jobs have been done in a given time

and if there is a standard time for each of these jobs, then by finding the ratio of the total actual time to the total standard time, it may be assumed for all practical purposes that *this ratio will hold for the individual jobs themselves*. And as with time so with direct wages.

As an example, if the standard figures were as before, 460 hr. and $202.50 and the actual were 506 hr. and $232.87, giving a ratio for time of 100 : 110 and for wages of 100 : 115, then the actual cost of any particular job will be its standard time and wages multiplied by these ratios. Thus, if a certain job included in the fifty in question had standard time 12 hr. and standard direct wages $5.28, then its actual cost will be 13.2 hr. and $6.07 direct wages.

This method, which is claimed to make a "short cut" to individual costs, has as its only advantage the small economy obtainable by avoidance of recording the individual costs. In some cases it is justifiable, in others it may easily be dangerous, as all averaging methods are likely to be unless watched with great care.

Limitations of the Method.—Where a large number of insignificant jobs are being worked on, as on the drilling machines of some machine shops, the method offers advantages. The scope for individual errors of any significance is then very small, even though the standard times are themselves only approximately correct. Errors in the standards will, in all probability, affect certain jobs more than others, but where the total amount involved is relatively small and the amount of detail required to cost each individual change of job considerable, a saving is effected and no great injustice is done in the long run.

The matter is quite otherwise in proportion as these special conditions are departed from. The longer the period over which the averaging takes place and the higher the wage rates involved and the greater the standard time on each job the more danger there is that erroneous standards may affect considerable sums, and that some jobs will actually have been above the ratio and some below to a serious degree. The method, in fact, is closely analogous to the distributing of burden by means of ratios, only that here we are dealing with hours and direct wages and not with overhead. It follows that all the drawbacks and pitfalls of the one method are to be found in the other.

Errors Due to Costing by Efficiency Ratios.—The way in which errors in the standard affects costs throughout the whole series of

jobs included in one ratio group-such errors being *distributed* over every job in the group—may be seen from the following example

Figure 26 shows standard time and standard wages of six jobs, the wages being at the rate of 50 cts an hour for all jobs It is assumed that these jobs have been carried through in a certain period, 1,170 hr , at a cost for direct wages of $585 We have, then,

Standard hours, 1,100	*Wages*, $550	*Ratio* 100 106 36 *for both time and*
Actual hours, 1,170	*Wages*, $585	*wages*

Having arrived at the ratio, the next step is to apply it to the standard costs of the individual jobs in order to find their individ-

Job No	Std hours	Std direct wages	Wages per ratio	Ratio	Real job time	Real job wages
1	100	$ 50 00	$ 53 18	Std wages,	100	$ 50 00
2	300	150 00	159 55	$550	330	165 00
3	100	50 00	53 18	Actual wages,	100	50 00
4	400	200 00	212 73	$585	440	220 00
5	100	50 00	53 18	Ratio,	100	50 00
6	100	50 00	53 18	100 106 36	100	50 00
Total	1,100	$550 00	$585 00		1 170	$585 00

NOTE —Wage rate 50 cts per hour for all jobs

FIG 26 —Errors in standard cost affect all costs in the ratio group

ual costs This is effected by multiplying each standard wage cost by the ratio 106 36 The results being as the column headed Wages per ratio As a check, the total $550 of standard costs is also multiplied, giving $584 98, or practically $585, the amount of actual wages expended on the jobs

It will be observed that four of the jobs are costed at $53 18 and the other two at $159 55 and $212 73, respectively It must now be seen if these are correct There is, of course, nothing on the face of the figures to show that they are not

It is further assumed that the shop is 100 per cent efficient, that is to say, the time actually taken was the lowest possible time, but this state of affairs is not disclosed by the figures But if it is assumed that the efficiency of the shop was 100 per cent, then it follows that the increased total of time taken, namely, 1,170

hr instead of 1,100, was due to an error or errors in standard time There is no possible way of finding this out, but it may be said, constructively, that the error lies in jobs 2 and 4 both of which are 10 per cent too low Bearing this in mind, the true cost of the jobs may now be considered

If, instead of finding the individual cost of these jobs by ratio, they had been costed separately in the usual manner, then the time and wages would be as the two right-hand columns in Fig 26 The four jobs that are correctly standardized would come out at 100 hr and $50 each, which corresponds exactly with standard, but the two jobs 2 and 4 would be

No 2, *standard,* 300, *hr* , $150 *wages actual,* 330, *hr* , $165, *wages*
No 4, *standard,* 400, *hr* , $200 *wages actual,* 440, *hr* , $220, *wages*

That is to say, the actual time and wages on these two jobs come out 10 per cent above standard, while the remainder of the jobs are true to standard As it is assumed, constructively, that the shop is 100 per cent efficient, it is evident that these last costs, taken out separately, are the true representation of what took place

Error Is Distributed over All the Jobs in Group —Now, if we are using standard costs merely as a datum, an error of 10 per cent would not be a very serious matter, as we shall presently see, but when standard costs are used as a "short cut" to the costing of a number of jobs in a group, then *any error in standard will give erroneous costs for every one of the jobs,* save in the unlikely case that errors in opposite directions cancel out, in which case only the jobs with the incorrect standards will be affected

This is shown very clearly by Fig 26, in which the 10 per cent error in two important jobs in the group has the effect, *first,* of making the costs of the correctly standardized jobs too high, and, *second,* making the costs of the jobs which are incorrectly standardized too low The four correct jobs have come out 6 36 per cent too high, and the other two 3 3 per cent too low

The serious matter about this condition of affairs is that, if time and wages on individual jobs have not been recorded, there is *no possible way of finding out the truth* There is not even any check on the accuracy of individual standards All that is known is that a certain group of jobs standardized at 1,100 hr have taken 1,170 hr , but it is pure assumption to consider this as an indication of inefficiency As in the case above cited, it may be

wholly or in part due to incorrect standardization. And there is the further mischief that, under such conditions, jobs which are correctly standardized are themselves costed incorrectly on this method.

Efficiency Ratios Based on Output.—In some industries where long runs of product are usual, executives are more accustomed to look at the results of a day's or a week's output instead of focusing attention on subdivision into jobs. Though no new principle is involved, the facts of production are seen from a somewhat different angle, and it will be well, therefore, to consider an example of standardized direct-wage cost based on output.

Conditions of the Problem.—We may assume a shop (Fig. 27) containing 20 operators and 20 machines, the working month being

Standard output	Standard hours	Average wage rate	Standard wages	Standard time per piece	Standard wages per piece
12,000	4,000	30 cts	$1,200	20 min	10 cts

FIG. 27.—Standardized output for 1 month.

200 hr., thus giving a total manufacturing capacity of 4,000 hr. All machines are exactly alike and have an hourly process rate of $1.05, though we have nothing to do with this at present. The average wage rate is 30 cts., which makes a total of $1,200 for the 4,000-hr. week.

Preliminary study of operations has led to the fixing of standard time for doing the job on one piece at 20 min. In 4,000 hr. the standard output, therefore, will be 12,000 pieces. Correspondingly, the standard wage per piece will be 10 cts.

Output with One Variation from Standard.—In Fig. 28 are shown the results of a month's recorded work. Only 3,600 hr. have actually been worked by the machines and 400 hr. have been idle, 9,818 pieces have been produced instead of 12,000, and wages have been $1,080 instead of $1,200. What is the best way of presenting these results in a significant fashion?

In the first place there has been a waste of 10 per cent of the manufacturing capacity, but this does not affect the direct-wage cost and will be considered in the next chapter. It may be said,

however, that the loss on this account amounts to $420 or about 4 3 cts per piece produced

It will be observed from Fig 28 that though the average *wage rate* has remained the same, the average *wage cost per piece* has risen This implies that a longer processing time than standard

Actual output	Actual hours	Average wage rate	Actual wages	Actual time per piece	Actual wages per piece
9,818	3,600	30 cts	$1,080	22 min	11 cts

FIG 28 —Actual output for 1 month One variation from standard

has been incurred The monetary value of this increased time is found, thus

Actual wage cost of 9,818 pieces	$1,080 00
Standard wage cost (9,818 @ 10 cts)	981 80[1]
Loss due to longer processing	$ 98 20

[1] If the standard wage cost per piece has not been worked out the standard cost of actual output can be found thus

$$\frac{\text{Standard wage} \times \text{actual output}}{\text{Standard output}} = \text{standard wage cost of actual output}$$

It will be remembered that there are only two possible variations of wage cost from standard One, as above, arising from a longer processing time being incurred, and the other arising from a higher wage rate being concerned As the average wage in Fig 28 (30 cts) is the same as the standard in Fig 27, it is evident that this latter variation is absent in this example

The results of the month's work may be expressed in ratios as follows

Standard to actual time per piece (20 22 min)	100 110
Standard to actual wages per piece (10 11 cts)	100 110
Loss due to higher time than standard	$98 20
Standard to actual output (12,000 9,818)	100 82 (81 81)
Utilized to wasted capacity (4,000 3,600 hr)	100 90

Output with Two Variations from Standard—In Fig 29 the results of a second month's work are presented In this month there is the same output in the same number of hours as in Fig 28, but a higher total of wages Therefore, while the time per piece (22 min) remains the same as in the last example, the wage cost

per piece has risen from 11 to 11 73 cts How can the monetary value of these two variations from standard be found?

First, find the value of the combined variation

Actual wage cost of 9,818 pieces	$1,152 00
Standard wage cost (9,818 @ 10 cts)	981 80
Excess over standard	$ 170 20

Part of this will be attributable to a higher wage rate and part to longer time of processing These are separated as follows

Excess over standard, as above	$170 20
Deduct excess due to higher wage rate (3,600 hr @ 2 cts)	72 00
Excess due to longer time	$ 98 20

This last, of course, corresponds with the loss found in the case of Fig 28, because the only difference between Figs 28 and 29

Actual output	Actual hours	Average wage rate	Actual wages	Actual time per piece	Actual wages per piece
9,818	3,600	32 cts	$1,152	22 min	11 73 cts

FIG 29 —Actual output for 1 month Two variations from standard

is in respect of a higher wage rate, amounting to an average of 2 cts an hour The results of this second month's operations may now be set out as

[1]Standard to actual time per piece (20 22 min)	100 110
Standard to actual wages per piece (10 11 73 cts)	100 117 3
Loss due to longer time of processing	$ 98 20
Loss due to higher wage rate	72 00
Total loss due to higher direct cost	$170 20
[1]Standard to actual output (12,000 9,818)	100 82
[1]Utilized to wasted capacity (4,000 3,600 hr)	100 90

[1] These items are the same in both weeks

The monetary value of loss due to higher wage rate and to longer processing time must not be taken too literally It is only an actual out-of-pocket loss if the standard times and rates are absolutely correct, because that would signify that the work *ought* to have been done at the standard price But further experience might show that, in actual practice, 22 and not 20

min was the practicable working average time of processing In this case the item $98 20 would not be a loss but a legitimate part of the cost of the job

The same argument applies to the $72 loss arising from the higher wage rate Is this a temporary and accidental or a permanent condition? Obviously, if the latter, this item must form part of legitimate cost, and the standard be modified accordingly

Output Containing Lots —The above examples assume that the product is uniform in character and in processing, *i e*, that all of the 12,000 pieces are alike and are treated alike Then, of course, any one or any hundred pieces taken at random would have the same cost In other words, it would be correct to assume that the direct-wage cost ratio (100 110) held good for any piece whatever

But if the product were being run through in lots or batches of, say, 1,000 pieces, and one lot differed from another either in respect of material or in the operations performed on it, then it would be taking a long chance and making a quite unjustifiable assumption if it were held that the efficiency ratio 100 110 applied to all lots alike As soon as lots differing however slightly, one from another, are in question we come back to the conditions discussed where jobs are being costed (p 112) It is, of course, possible that the ratio 100 110 does apply to all equally, but cost accounting has nothing to do with possibilities or "might be's," and, in the absence of a record of processing time and wages on the separate lots, there is no proof that certain of the lots and others are responsible for the discrepancy with standard Some of the jobs might, for example, be 100 120 and others 100 92, but unless time and wages are recorded for each lot, entire uncertainty on the point must rule

Proper Use of Standardized Costs —The practice of trying to replace properly recorded costs by calculations derived from application of ratios of efficiency to groups of jobs is only justified, *first*, where, as in the case of the drilling machines cited above, trifling individual amounts are in question, and, *second*, where the standard cost has been *proved* to be accurate by repeated performance of the job at the standard rate Even in the latter case the taking out at least of the *time* on individual jobs should be done regularly, so that the exact place and amount of individual departures from standard can be traced and examined

The proper use of a standardized cost is as a datum, toward or away from which the successive records of actual performance will move on each occasion of the job passing through the shops, indicating either greater or lesser efficiency in such performance For this purpose absolute accuracy of the datum is not so important, and it may very well be derived from previous records or from a brief time study of the principal features of the operation

This aspect of standard cost does not enter into the scope of this book, for its value lies wholly in the domain of the production engineer and not in that of the accountant The claim persistently made by some production men that what they term "historical" costing, that is, actual and verifiable record of what did happen, is of no service and that this well-established practice must give way to what are termed "predetermined" costs is due to a complete confusion of terms and to an ignoring of the real purpose of costs

So-called "predetermined costs" are not costs at all, but only more or less accurate forecasts They have their value to production, and, properly handled, it is a very great value, but unless checked and proved by accounting methods there is, as has been shown above, great likelihood of considerable errors being introduced, not only into the cost of jobs incorrectly standardized but also into the cost of correctly standardized ones as well

Promptitude in Costing —Advocates of the plan of replacing true records by predetermined costs make much of the argument that a record of what has happened (*i e*, what they term "historical costs") is of no value to the production man who is interested in reducing costs There is much to be said for this complaint, where the older methods of costing are in vogue, since by these methods costs cannot generally be made available until the end of a financial period, usually the current month, by which time, they are, it must be admitted, rather stale

But on the other hand, neither can costs prepared by efficiency ratios in groups be forthcoming as redhot as is desirable Delay will vary according to circumstances, but, obviously, the ratio itself cannot be calculated until the last job in the group is completed

With modern cost methods, including standardized process rates, there should be no delay in making known the cost of any

job within a few minutes of its completion, if necessary, but as a matter of regular routine not later than next day And such a cost will be a real cost, with no guesswork about it, no dependence on averages or ratios, or any other mathematical jugglery

Purpose of Costs—The purpose of costs is two-fold *First,* to show whether the job has been done in reasonable time and at a reasonable cost This reasonableness is determined either, as formerly, by the judgment of the foreman or superintendent, or by comparison with a datum or standard This standard, again, may be an approximate one, fixed after a more or less close view of the operation, or it may be derived from previous records, or, as is the latest practice in some industries, by a very rigorous and careful time and motion study *But no true comparison between actual and expected cost can be made save by an "historical" record of what actually took place in the utmost detail that is possible* This purpose of costs belongs to production engineering and has nothing to do with the cost accountant, save as he provides the actual cost data for the comparison

The *second* purpose of costs is a financial one The profit made by the manufacturing operations as a whole is *built up* out of numerous small items of profit made on separate jobs or orders While profit as a whole will appear from the profit and loss account and no cost accounts are necessary to give the information, the profit on individual orders or jobs can be ascertained only by means of setting the cost of production against the selling price This, of course, implies that if the whole profit arises from 500 items, the individual costs of the 500 items, set against the individual sale prices, will correspond exactly, when aggregated, with the total in profit and loss account

Need for Simple Truth—The use of percentages and the calculation of loss by classes, though very valuable to the production department, should not be allowed to gain entry into the financial accounting, for the simple reason that once accounting gets off the solid basis of fact and into the region of suppositions, the results it presents are subject to all kinds of qualifications and reservations that do not appear on the surface Under such conditions confidence in accounts would be seriously undermined, and their value thereby almost nullified

Wasted Direct Labor—It was pointed out in a previous chapter that a salient difference between overhead or service and direct labor is that while the former does not cease, or at best only

ceases partially, when a machine is shut down, the latter can be and is cut off entirely

But this applies only to those cases in which a machine is intentionally and deliberately shut down In many plants there is great wastage of direct labor, though, as it is charged to one or another job or included in the total of direct wages where costs are based on output, this wastage does not come to light but passes automatically into cost of job or output without anyone's being the wiser

This type of waste is due to what may be termed *intermissions*, the space of time between the completion of one job and the beginning of the next, due to new work not being ready or to any one of several preventable causes Even the most elaborate time-recording systems fail, as a rule, to catch this kind of item, or to reveal the amount of money that is lost by reason of it It is only where each machine is fitted with a recording device showing the periods of actual operation that any record of this, sometimes alarming, loss will be forthcoming

Inasmuch as in practically every case this type of loss is accompanied by a corresponding loss of process-rate time (which also, of course, fails to get recorded as loss), discussion of the matter will be made in connection with process rates and the working of production centers, and it will suffice at this point to note its existence

Conclusion—It has been seen, in this chapter, that standardization, as it refers to direct-wages cost, consists of two elements, first, standardization of the *time* of the job and, second, standardization of the *wage rate* applicable to the work Combination of the two provides a standard-wage cost for the job

In presenting results it is possible, where a variation from standard has happened, to classify the extra expenditure in two categories corresponding to the above elements The extra cost due to longer processing time can be shown as an item separate from the extra cost due to a higher wage rate having been applied to the work

It is also possible to express results as ratios of standard to actual, and the observation of these ratios on successive occasions affords a convenient method of watching the efficiency of operations, but this is a matter beyond the scope of the present work

The dangers of relying upon blanket ratios to afford guidance to the true cost of jobs which have not been subject to detailed

costing have been shown to be the same as those of the method of applying burden by means of percentages or hourly burdens, and to be subject to much the same inaccuracies

Though the whole subject of direct wages is somewhat outside the proper sphere of this book, it has been judged well thus briefly to discuss the subject, since the same term "standardization" is applied to time and wages as described in this chapter and also to the setting up of service factors and process rates But as a matter of fact, the kind of standardization that leads to the latter is quite a distinct class of operation and rests on quite different principles, as will be shown in the next chapter

Another reason for including this study of direct-wage costs is that, as such costs are necessarily part of the total cost of jobs or outputs, there will be occasion, presently, to consider them in connection with process rates and processing time The ultimate effect of standardization of cost cannot be understood without reference to that of time and wages cost, and though there may be occasions when a cost contains process rates and no direct labor, there are, on the other hand, no costs that are not based on the element of time, which time may be standardized time as considered above

CHAPTER XI

STANDARDIZATION

II OF OVERHEAD EXPENSE

All standardization is ultimately connected with and is based on time In making a standardized wage cost, as discussed in the previous chapter, we virtually predict that in a given time (standard time of operation) certain changes in material will have been accomplished, and that during this period a certain rate of wages will have been unchanged, *i e*, will have been held constant

In considering the standardization of overhead expense the time basis is also all important By budgeting all overhead items, classified into service factor groups, we ascertain the cost of manufacturing capacity for the plant, taken as a whole, for one year Dividing this amount by the total working hours of the year gives an hourly rate which is the cost of manufacturing capacity *of the whole plant* for one hour Next, a division into departments is made, the annual cost of service in each department being divided by the working hours, giving the cost of the manufacturing capacity *of that department as a whole* for one hour Sometimes it is necessary to go further, and obtain a separate hourly rate *for each production center* in the department In all these cases we are considering the incidence of various forms of overhead on production as measured by what happens in units of time

Overhead Related to Time in Two Different Ways —At the outset the assembly of cost of manufacturing capacity is met by a curious condition Certain of the expenditures that go to make up overhead have no obvious relation and others have a very close relation to working hours This division into fixed and variable charges is one of the complications that have beset the question of overhead from the beginning

The distinction between the two kinds of overhead may, however, be roughly cleared up by considering that such charges

as are by their nature annual, such as interest, depreciation, certain salaries, etc., are *divisible* by working hours, while other charges, such as labor in all its applications, are to be *multiplied* by working hours. This is only a very rough and ready classification, but it does bring out the essential point of difference between the two classes *in terms of time*.

Entrance of Service Factors.—In this discussion we are, however, maintaining the principle that indirect expense should not be grouped into one sum and labelled "overhead," but that, from the beginning, each item of expenditure should be allotted to one of several classes (service factors) which represent the cost of services to direct production or, in other words, the cost of manufacturing capacity as built up out of such factors.

A service factor represents virtually a separate business carried on by the manufacturer to assist production, such as the business of property owner, of power manufacturer, etc., and it is evident, therefore, that we have to do two things: first, to ascertain what it costs to carry on the factor service for a year, and, second, to find a basis for charging a correct portion of this total to production as and when utilized.

Expenditures on a service factor will, themselves, be made up of the two classes of expense mentioned above. Some items will tend to become *less* per unit period of charge, in proportion as the time over which the service is spread is larger, and others will tend to *increase* in total annual amount in proportion as longer hours are worked.

With these varying elements of cost in most service factors, it becomes necessary, in order to have any solid foundation on which to build, to introduce the principle of *standardization* into the construction of service factors.

Service Factor Standardization.—The standardization of a service factor is virtually the same thing as reducing it to a *rent*. This was exemplified as applied to small-scale production in Part I. However much the scale of production may be increased precisely the same principles are involved, although a further development, that of "departmentalization," will now come between the settlement of a rent and its reduction to elements of process rates. We need not consider departmentalization at present. As a preliminary exercise the case of a non-departmentalized plant (which is the same thing as a plant with only one department) will be discussed.

What is the salient feature of a rent? It is the elimination of the influence of local expenditures, a smoothing out of the curve, so that such rent does not rise or fall in any short period, such as a week or month, even though expenditures may have been greater in one such short period than in another In other words, expenditures are standardized *over a sufficiently long period* to absorb local irregularities In one month the rent receivable for that month may be wholly spent on a repair, but in other months nothing will be spent *The rent for the year is so standardized that the same amount is paid by the tenant month after month*

In the case of an ordinary rent, the basis of dividing the standardized annual amount so as to determine the payments by the tenant is very simple Usually it is a matter of simple division by either twelve or fifty-two, according as payments are monthly or weekly Nothing quite so simple as this can be done in the case of service factors, because these contain certain elements that are not natural annual charges

Annual and Period Charges—This point requires some examination All *ordinary rents* are built up of annual charges, such as interest, depreciation, etc Even repairs, though an intermittent expense, is reducible to a fair average annual total It is always the cost of repairs *for a year* that is included in rent Rent, therefore, contains only one class of expenditures, namely, those which are *divisible* by a working period, which in this case is a month or week

Service factors, on the other hand, contain all of these items and also others, which are not of the naturally divisible class Divisible elements are those of which the annual total is practically unaffected by the length of working periods, within reason Annual depreciation, for example, would be much the same for a 48-, a 50- or a 52-hr week Annual interest is wholly unaffected by length of working hours Annual cost of building repairs would be little different whether the shorter or longer week were used

But all that class of expenditure that consists of hourly service, such as the work of transport men, subforemen and timekeepers, if paid by the hour, laborers, etc, will vary in total amount in close proportion to the actual working hours

On the other hand, not all indirect labor is expended in strict proportion to working hours If a given shop is working over-

time, it does not follow that all services have equally extended operation

Natural Stages of Standardization —In setting out to effect the standardization of overhead into service factors and in applying these as process cost (*i e*, the cost of manufacturing capacity), there are certain natural stages or halting places, each of which finds the application of process cost carried to smaller and smaller groups of processes, until, finally, each individual process may have its own individual process rate

First Stage —From what has been said as to overhead being the cost of manufacturing capacity, it follows that the first stage is reached when we set *all* overhead (classified into service factors) against *all* capacity The annual total of all service factors is the annual cost of all manufacturing capacity This annual value may be, then, converted into an hourly value by dividing it by the number of working hours in the year We have then the hourly cost of manufacturing capacity for the plant as a whole

Only in very simple conditions would such an hourly rate be practically useful A small concern turning out only one article, as one weave of cloth, one variety of soap or other chemical compound, or a single variety of stamped piece, would be able to consider its whole plant *as a single process*, and the combined hourly value of all service factors (that is, of all overhead) would be the hourly process rate of such process Under such simple conditions it would sometimes not be necessary to carry standardization into any narrower sphere of application

Second Stage —In very few plants are conditions as simple as this For the most part operations are diverse and are consequently regarded as being separated into departments If within the department there is no diversity of processing, then such department may be considered as a single process But in order to find the cost of the annual or hourly manufacturing capacity of such departments, it is first necessary to assemble all the local items of service expense arising within each department, and to add to these the department's proper share of service expense arising outside the department The two varieties, together, constitute, of course, the annual and hourly service cost (or cost of the manufacturing capacity) of the department Then, when all departments have been thus arranged, the whole of the overhead will have been allotted to departments, and thus is said to be *departmentalized*

If the work done in the various departments is in each case a single process (or chain of processes), no further subdivision of service cost is necessary The cost of 1 hour's manufacturing capacity of the department is the process cost of the product turned out If there are 20 machines in the department and they are all alike, and if the working hours are, say, 200 in a given month, then there will be 4,000 process hours in the month, and if all the overhead (service factors) aggregates at $6,000 for the month, then the process rate will be $1 50 per hour for any machine

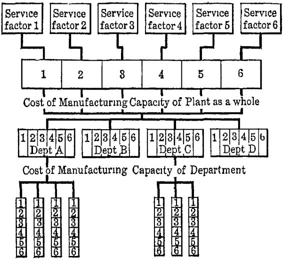
In a large variety of industries no further stage of subdivision of service-factor charge is necessary A department having a homogeneous output which is processed at exactly similar machines can have only one process rate Moreover, even when there are differences in machines, this will still be the case, provided that machines are arranged in sequences and that all product passes through the series in exactly the same manner Each series can be regarded as a single machine, and, if there are five or ten such series all exactly alike, they can be regarded as five or ten precisely similar machines, and no advantage would be gained by setting up individual machine costs The process rate will be the same for all five or all ten of the sets of machines

Third Stage—If, however, product does not flow uniformly through all machines but takes longer to pass some machines than others, or if machines (not being in sequence) are themselves different one to the other, or if part of product passes through some machinery and not others, then it is obvious that uniformity of processing conditions within the department is no longer obtaining If we have twenty machines and six of them form one group, three another, and the remaining eleven are all different, then no one process rate will be applicable to all of them Under these conditions we must undertake the final analysis of service and determine how each service is absorbed by individual machines or production centers We shall then have *as many different process rates as there are differences between the type and duty of production centers*

This is the ultimate possible subdivision When every production center has its own individual process rate we know all that it is possible to know about the cost of manufacturing capacity If knowledge of the cost of manufacturing capacity of the plant as a whole, or of the output of individual departments as a whole

is too vague and general, then, by completing the third stage, the utmost precision in costing processes is reached, since by this means the process cost of every single piece or lot of product on whatever machine it may have been worked is known in final detail

What has been done here is, in fact, *the carrying out of departmentalization as far as the individual production center* As departments must have homogeneous processing to enable a single process rate to be applied to their work, in the present case we have narrowed down the application of service factors so



Cost of manufacturing capacity of production center

FIG 30

that each machine or production center can carry on an individual type of processing and yet be costed with equal precision But, as remarked above, this final refinement is unnecessary so long as we can divide up manufacturing operations into departments of homogeneous processing It is only when it becomes necessary to include in one department several types of production center or varieties of product which are not all processed alike that the hourly process rate must be worked out for each such center

Diagram of the Three Stages of Standardization—In Fig 30 the foregoing stages of standardization are exhibited in diagram form First, the separate service factors are consolidated in one

total, which represents the cost of manufacturing capacity (preparedness) of the plant as a whole This stage can rarely be utilized, inasmuch as most plants need departmentalization

Next, four departments (A, B, C and D) are shown, and in each appears that department's share of each factor The consolidated total would be the cost of manufacturing capacity of that department In many cases this is as far as standardization need be carried, as, for example, when the product is homogeneous and the department's output can be expressed in thousands, yards, pounds, etc Process cost is found by dividing the standard number of working hours into the total cost of manufacturing capacity

The final stage is reached, as shown for two departments (A and C) in the diagram, when standardization is carried as far as the individual production centers (*four* shown for Dept A and *three* for Dept C) Each such center takes up its own individual share of each factor, and the consolidated total divided by standard working hours gives the hourly process rate for the production center On this plan, the process cost of every different job, in whatever respects it may resemble or differ from other jobs, is accurately found Such job may consist of one, or a thousand, or a million units, and take half an hour or several days, without prejudice to the accuracy of costing

Accuracy of Standardized Factors—In the last chapter attention was called to the difficulties surrounding the use of standardized direct cost It may be very well asked why and in what degree standardization of service factors can be said to be more reliable than standardization of direct time and wages on individual jobs If a certain amount of distrust is justifiable in the one case, why not in the other?

Both classes of standardization are really made on the principle of infinitesimals In the case of standard operation time, based on time and motion study, the standard is built up out of a large number of small movements, so that errors in one or two of these will not make a serious error when all are aggregated The larger the number of elements studied and recorded, which means the smaller the individual observations, the greater will be the chance of reasonable accuracy, because the smaller will be the amount of an individual misreading or error

In the same way the setting up of service factors is based on observation of a large number of small items, each of which is

made as accurate as observation will allow, and the value of these observations for a whole year is made the basis of standardization Process rates are usually hourly, that is, they amount, usually, only to about *one twenty-four-hundredth part* of the annual charge to the process, and, consequently, to produce a serious error in an hourly rate quite a considerable amount of inaccuracy must have existed in the computation of the annual service charges

But this computation is not merely that of a vague expenditure known as "overhead" The division of all expenditure into service factors enables the scrutiny to become far more precise than it would be if merely an assembly of annual expenditures in a general way were in question It enables the mind to form a clear picture of different classes of activity, because expenditures are seen in groups and in relation to the ends to be effected In tabulating the expenditure of the power factor, or of the supervision factor, or of the storekeeping-transport factor, the essential or necessary character of this or the other item of expenditure is easily reviewed Consequently, when some hundreds of items are assembled in perhaps seven or eight factors, though an item here or there may have been misjudged, the final result should be very close to actual figures, provided conditions are unchanged

Control of Accuracy of Service Factors —In the case of standardized time and wages cost, as referred to in the last chapter, it is pointed out that the justification of a standard was actual performance of the work within or at the given limits The more frequently the performance is repeated and the standard reached the more confidence in the accuracy of the standard will be felt

In the same way, confirmation of the accuracy of standardization of service factors can be brought about only by regular comparison of standard figures with actual figures Of course, a considerable portion of the items which make up annual service factors, such as interest, depreciation, insurance, taxes, salaries, fuel cost, etc , are very little subject to alteration to a hurtful degree during the twelvemonth, and when such alteration takes place it is known at once and, if necessary, new service factors put into operation

The items which arise from hourly labor, and such items enter into most service factors, demand the most careful scrutiny It is one of the merits of the service-factor method that it forces careful forecasting or budgeting so subdivided (by factors and by departments) that unauthorized increase in any item is seen

at once Such increases are either temporary or permanent If the former, they may in general be ignored If the latter, modification of the factor may be necessary, if the amount is sufficient to affect the hourly rates

The most difficult item to control is that of repairs The amount allotted to repairs annually in each factor should, of course, be based on experience But, even so, there will be in general no correspondence between the amount actually expended *in any one month* and the particular amounts scheduled or forecasted, as explained above when considering factors as rents In many cases, however, there will be a repair staff, the size of which is based on the program of repairs for the year, as assembled in factors This implies that every month a given amount will be applicable for repairs, and, if this sum is compared with the total actual repairs for all factors, a fair control is obtained The amount budgeted against any machine or individual piece of equipment, building, etc, is controllable only by comparison at the end of the year, but the total allowance for repairs can be compared with actual, month by month, and should agree with reasonable closeness

Repair allowances in budgets will, in general, be maximum limits When, therefore, it is seen early in the year that such amounts have been attained or passed, it is a danger signal and shows evidence for inquiry This matter will be discussed more fully in a later chapter

Conclusion —The general idea underlying standardization of overhead will be understood from what has been said above to include

1 Segregation of all non-processing operations into certain groups or factors, each of which represents a definite kind of business, giving a different kind of service to production

2 Within each of these factor groups an assembly of annual expenditures is budgeted, certain of these being natural annual amounts, which are *divisible* by working hours, and others being built up amounts which tend to increase in proportion to or are *multipliable* by working hours

3 Items like repairs are based on what experience gives as the *annual* cost of such work and are budgeted separately against each class of equipment liable to repair within each factor

4 Standardization is carried out in at least two and frequently three stages First, the aggregate of all service factors is assem-

bled and set against the total of hours worked This gives the cost of manufacturing capacity for the whole plant, considered as one department and one production center Second, instead of having the total of each service factor in one sum, it is divided into departmental portions, each department being budgeted separately Setting this forecasted amount against the total hours worked in a department gives the cost of manufacturing capacity for that department In many cases no further subdivision of factors is necessary

A third stage is reached when the operations of a department are not homogeneous In this case each service factor is given the extreme of departmentalization, namely, as far as the individual production center *Each production center virtually becomes a separate department for costing purposes*, and its output is costed with entire independence of what other production centers may or may not be doing

5 Control of the accuracy of factors and, therefore, of process rates, depends on accuracy of forecasting or budgeting and is based on the principle of infinitesimals, which gives a reasonable chance that errors will not be unduly serious This is safeguarded by comparisons between actual and budgeted figures, factor by factor, each month Any permanent discrepancies will be considered in the light of their quantitative influence on process rates At any time process rates may be recalculated, and, if this is done on a modern electric arithmometer, a very small expense is involved even when a considerable number of process rates are to be refixed

CHAPTER XII

STANDARDIZATION

III OF SERVICE FACTORS

While it is not very often, in practice, that the whole plant can be treated as one department, it is possible with a single homogeneous product for this to be the case Such a plant affords, of course, the simplest example of standardization of overhead, and for that reason provides a suitable model for study In the present chapter such a plant is assumed to be under discussion

Setting Up Service Factors —The first step in establishing process rates will always be a decision on what service factors are present Certain of these are present in all plants, but there are sometimes special services, such as, for example, compressed-air service, tool-room service, gas production, chlorine production, making of special dopes, etc , which are individual to single industries or even to a single plant At the present stage, however, we are not interested in these special factors, as they are merely *additional*, and the principles on which they are set up will easily be understood from the examples of ordinary service factors here considered

The usual service factors present in practically all plants may be enumerated as follows

1 *Land-buildings* (*Space*) *Factor* —This factor represents, in the main, the function of the manufacturer as *property owner* or landlord Most of the expenditure included in such a factor corresponds exactly to that which would be included if, instead of using the property for manufacturing purposes, it were rented to someone else For convenience, however, certain items are included, such as cleaning, lighting and heating, which bring up the factor to the status of a standardized charge for the property *maintained ready for use* or, in other words, in a state of *preparedness for production* Of course, if the property were rented to someone else, these last three items would usually fall on the rentee

In some instances it may be more convenient to include lighting and heating as part of the power factor but this is mainly a matter of the most convenient treatment of figures. As will be seen later, the end attained is the same whichever method is employed.

In the simplest case, namely, where the building is rented, the space factor will consist mainly of this rent, plus taxation and the annual cost of cleaning, lighting and heating. On the other hand, where it is owned by the manufacturer, charges for interest and depreciation on the capital value, for insurance and an estimated allowance of the cost of annual repairs will be substituted for the rent payable to the landlord. As this and all other usual factors will be considered at length in later chapters, further detail of what should be included and how will not now be discussed. The principal point to observe is that the whole of the expenditure for the year, being aggregated, forms a grand total which is *one* element, and a very clearly defined and separate one, of the cost of manufacturing capacity of the plant for twelve months.

2. *Power Factor.*—This factor represents the function of the manufacturer as owner of a power station, whether the power plant furnishes 50 or 50,000 hp. It is, as a rule, a more complex factor to set up than the land-buildings factor, because power is frequently used in more than one form and is applied to more than one use. It is usually arranged to include not only the cost of upkeep of the power plant itself but also of all the transmission appliances wherever used, such as belts, shafting, motors, main and subsidiary wiring, meters, piping for steam or hot water, and so forth.

This is equivalent to saying that the power factor represents the cost of power in any of its forms, *e.g.*, current maybe at more than one voltage, steam, exhaust steam, hot water, etc., *delivered at the point of consumption.* At its simplest, the power factor may be made up simply of the annual bills for current from the public service mains, plus the upkeep and repair, interest and depreciation of such motors, main and branch wiring, meters, etc., as are used for distributing the current to points of consumption within the plant.

When power is generated in the plant, the items that go into power factor are such as would be so charged were the power plant being maintained as a public service station for supplying

current to someone else, plus charges for internal equipment as indicated in the case of current purchased from outside The dividing line between the power factor and all other overhead is thus fairly clear, but it must not be overlooked that a portion of the annual land-buildings factor will be chargeable to the power plant in respect of the space for fuel storage and the building or buildings occupied for power generating purposes

When these items have been aggregated into an annual total, this total represents the *cost of preparedness to maintain delivery* of so many kilowatts of current or so many pounds of steam, for one year, at the points of consumption This forms another clearly defined element of the cost of manufacturing capacity of the plant for one year

3 *Supervision Factor* —The title of this factor is self-explanatory, but its scope will vary according to the size, variety and internal organization of the plant It is entitled "supervision" rather than "management" because it is confined to segregating the cost of the internal supervision of the plant as distinguished from the general expenses of administration It therefore includes the maintenance of the plant manager's or superintendent's staff, the production and inspection staff, foremen's salaries and that of their assistants or subforemen and, in fact, every expenditure that is incurred in the course of supervising, directing or guiding production

In a small plant such as is assumed here, the supervision factor would be small, but in some kinds of industry, particularly in the highly involved machine types, it becomes largely expanded and requires some study to arrange satisfactorily This aspect will, however, be treated at length in later chapters For the present it need only be noted that we have here a third clearly marked group of activity, and that the aggregate annual cost of this group of expenditures represents the maintenance of the supervision function in a *condition of preparedness to supervise and control output* This function has, of course, no analogue in any outside or purchased service that might be represented by a common rent, but it is an obvious and unmistakable element of the cost of processing just the same

4 *Storage-transport Factor* —In every plant the movement, handling and storage of material takes a great part, involving a variety of expenditure This factor is practically a double one, dealing on the one hand with the purchase, receipt, care and stor-

age of raw material (and sometimes of manufactured parts), and on the other with its movement between processes until final delivery into warehouse of finished goods

While the storage-transport factor is perhaps the most troublesome to set up when a departmentalized plant, or one in which departmentalization is carried as far as the individual production centers, is in question, since the problems arising from proper distribution or allotment of amounts are sometimes complex, yet there is very little difficulty in collecting and segregating the items that belong to it, which is what we are dealing with at present

Expenditures attributable to the storage-transport factor are in general fairly obvious They include annual cost of space for buildings or areas occupied by raw and half-manufactured material, interest, depreciation, insurance, etc , on the value of all shelving, weighing machines, bins and other stores equipment, the wages or salaries of purchasing and storekeeping staff, interest and insurance on current stores balances and similar items On the transport side the expenditures include interest, depreciation and insurance on cranes, conveyors, overhead travelers, tractors and trucks and the power charge involved in these, wages of transport men, including transport foreman and any other items having relation to the movement of goods In both classes allowances for repair of equipment will also be included

When all of these charges are aggregated into one annual total, they represent *the cost of preparedness to store, handle and move material* and, as such, are an obviously distinct and separate item of process cost, making the fourth group which is capable of being distinguished as an independent factor of such cost

5 *Productive Equipment Factor* —All the foregoing factors represent the annual cost of maintaining certain definite classes of service to production in a condition of preparedness to produce a given output The present factor is concerned with the annual cost of maintaining the actual productive equipment itself, that is, the machines, benches, floor spaces, etc , which form production centers with delivery points, as explained in Chap VIII

In the present instance, wherein we are considering the plant as a whole, the only steps necessary to set up the productive equipment factor are, first, to list all production centers, and, second, to set against each the capital value concerned Then, for each such production center, the annual charge for interest,

depreciation, insurance and taxes is calculated and set down An annual charge for repairs, taking into account the circumstances of each case, is then made against each center, and also a charge representing the annual cost of sundries, such as lubricating oil, cotton waste, etc , is made up In some cases a further allowance is set up for the annual cost of cleaning the machine

It will be obvious that all of these are localized charges individual to the production centers themselves They cannot by any stretch of imagination be considered as having any relation to another production center, or to the processing work done on any other such center When, therefore, they have all been set up and an aggregate total made, it follows that we have here the annual cost of *maintaining production centers in a condition of preparedness*, and that this cost is entirely independent of any other factor and is an obviously separate element of cost

6 *Organization Factor* —Most of the usual expenditures of a modern plant have now been taken up and assigned to one or another service factor All have very close relation to production and arise for the most part within the shops There remains, however, another class of expenditure, which corresponds to some extent with the classification "general expense," that usually figures prominently in older methods of burden distribution

The organization factor represents the annual cost of such parts of the annual organization as have not been previously assigned to a definite factor It includes, therefore, salaries of higher officials, of accountants and time and cost clerks, order offices, watchmen and the stationery, books, etc , used by them It also will include a portion of space factor on account of office buildings, and interest, depreciation and maintenance of typewriters, calculating machines, furniture and office appliances

This forms, for the most part, a fairly clearly defined group of expenditures, but, before these values can be assigned definitely to the organization factor, a preliminary scrutiny has to be made in regard to many of them, arising from the fact that in many offices, and to a certain degree in all offices, the work pertains not only to *production* but also to *selling* It is necessary, therefore, to divide up such expenditures so that production is charged only with its fair share of the total The method of doing this will be discussed later, at this stage it is only requisite to call attention to the principle

The net result of the foregoing will be that we have now an annual total representing the cost of administrative and other office services to production, which is, in effect, the cost of *maintaining such organization in a condition of preparedness to take care of the productive transactions*

Use of Service Factors —When the foregoing factors have been set up we have (in the absence of any special factors additional to these) the entire total of overhead expense arranged in six definite groups, which are entirely independent *The efficiency of one of these groups is not related to that of other groups,* but may be regarded on its own merits As the total of overhead expense has been defined as the cost of the manufacturing capacity of the plant as a whole, it is evident that each group or factor is the cost of maintaining the service it represents in a condition of preparedness to contribute to that manufacturing capacity, thus

The land-buildings or space factor is the cost of preparedness of buildings ready for use in the standard working period

The power factor is the cost of maintaining power supply adequate to furnish power for the standard working period

The supervision factor is the cost of providing the necessary supervision in a state of preparedness to deal with the operations of the standard working period

The stores-transport factor is the cost of maintaining a supply of material and of transporting it to and fro in quantity sufficient to constitute preparedness to handle output during the standard working period

The productive equipment factor is the cost of maintaining machines or other forms of production center in a state of preparedness to do processing during the standard working period

Finally, the organization factor is the cost of maintaining an administrative and office organization in sufficient amount to represent preparedness to handle the transactions which will arise during the standard working period

Having assembled these factors, the next question is their relation to the expected output This, as already pointed out, is based on *time* All the factors have been assembled at their annual value, and a considerable proportion of the items entering into them will have been calculated on the basis of an expected number of working hours If it is assumed that this basis was 2,400 hr in the year, then by dividing each factor total by 2,400 the value of each such factor for one hour is found

If then these (six) hourly amounts are added together, a sum is arrived at which represents the cost of all factors, taken together, for one hour

In other words, this is *an hourly process rate*

Hourly Process Rate.—Under the conditions here assumed, namely, that the plant consists of a single department with a homogeneous product, such as, for example, one size and variety of food product, or a packeted mixture of chemicals, such as a fungicide or disinfectant, or one variety of cloth or other textile material, then the total cost of the output of that product, on the basis of 1,000 units per hour, will be,

Process rate, 1 hr	$60
Direct labor, 1 hr	30
Total cost of processing	$90

$\frac{90}{1,000}$ = 9 cts per unit (package, yard, pound, etc)

These figures are, however, only applicable if the plant contains a single stream of production in which the raw material passes, stage by stage, through a series of machines in a continuous stream It may happen, however, that more than one such stream exists Instead of having a single machine at each stage of operation, there may be, say, six such machines all alike In this event there will be not one but six delivery points to be considered, any one of which may be working or not working independent of the others

Under these circumstances, if the hourly process rate for the whole plant is $60, this must be divided by six to find the hourly process rate for each delivery point, namely, $10 If, now, each delivery point has an output of 1,000 per hour, the process-rate cost per unit will be $10/1,000 or 1 ct

Stage Reached by Standardization.—It may be well at this point to review what has been effected by the arrangements described The question may be asked What has been standardized, and what end has been attained by this standardization?

In the first place, the collective term "overhead" has been exchanged for the idea of several independent groups of expenditure, each of which has its own separate efficiency and its own separate relation to the cost of manufacturing capacity of the plant as a whole

In the second place, these groups or factors have been set up on the basis of a given capacity for output, or, more exactly, on the basis of a given number of working hours in the year

Combination of all the factors represents, therefore, the cost of maintaining certain services during a given number of hours in the year. If production is actually maintained through this number of hours, then utilization of the manufacturing capacity thus provided will be 100 per cent. If, on the other hand, production falls short of this number of hours, then some of the manufacturing capacity provided will have been wasted.

The problem which has thus been attacked and settled is this: Given a certain number of working hours per annum, per month and per day, what is the cost of maintaining the whole organization in a state of preparedness during those periods? To facilitate accurate forecasting of the cost in question, we have considered the question from six different viewpoints, and from each of these have asked, What items are legitimately to be included in this service? Knowing that no expenditure is legitimate unless it is the price of a service to production, it becomes a matter of no insuperable difficulty to tabulate the different items that should enter into each service.

When the existence of an item is recognized and allowed, its annual value is ascertained. In a considerable number of cases (interest, depreciation, repairs allowance, salaries), the annual value is evident on the face of it. In other cases it is built up by considering its hourly value and how much of it will be consumed in the course of a year.

The end of the determination is reached when we have, on the one hand, a standardized number of working hours per year, and, on the other, the legitimate expenditure required to keep things moving in a productive sense during those hours. When a satisfactory tabulation of items has been effected, all that remains is to divide the total by the working hours to find the cost per hour of the manufacturing capacity of the plant.

Dividing Utilized from Wasted Capacity.—The cost per hour of manufacturing *capacity* has obviously no relation to the amount of *output*, any more than the purchase of a heavy winter overcoat has to the number of times it will be worn in the season. That will depend on the temperature of the winter days and is a matter that cannot be forecasted.

In the same way, though we can forecast with considerable accuracy the cost of manufacturing capacity for 2,400 hr. per year, it is impossible to foresee whether this will actually be utilized to the full. Even in the case of a simple plant with

only one department and one stream of product continually passing, it is not certain that unforeseen circumstances may not prevent the working of the full 2,400 hr A breakdown might occur, or a shortage of material, or a shortage of orders Suppose one or more of these accidents to happen, how is the standardized cost of capacity affected?

It is, of course, not affected at all, just as the price of the overcoat is not affected by its greater or lesser use Standardized process cost represents the cost of a maximum that should be realized under normal and reasonable conditions *It is, therefore, the cost at which work can be done* If, however, unforeseen hindrances prevent its full utilization, it means that some of the capacity has been wasted, not that the cost at which work can be done is any higher The cost of the work which *was* done is not affected This will be more fully discussed in the next chapter

Effect of Economies on Wasted Capacity—If there is any considerable failure to reach standard working hours, or, in other words, if a condition of "short time" exists, it will frequently be possible to lay off some classes of service labor and thus effect economies in overhead

The question now arises What relation has this economy to the cost of unutilized capacity on the one hand and to the cost of utilized capacity on the other?

Though this will be discussed in more detail later (as will also the *reverse* question of overtime), it may be said now that the only effect of such economies is to *reduce the loss* on wasted capacity The cost of output, that is, of utilized capacity, is not affected in any way, for it cannot be supposed that such economies have made the process cost of what was actually produced any cheaper While the proof of this cannot be offered here, a moment's reflection will show the truth of the statement The standardized process rate should represent the minimum reasonable cost of work If it does not, then this implies that items have been included in the standardized factors that were not legitimate, and that, as a matter of fact, less service would have produced the same result But if the economies in service have been possible only because less service was wanted, because of slack work conditions, then it follows that these economies have been made from the portion of capacity that was wasted, and not from the portion that was utilized

The results of a working period may, therefore, be shown as divisible into two portions

1 Output at standard process rate

2 Loss due to unutilized capacity, which will amount in value to the difference between total cost of capacity and utilized cost, less any economies effected

Thus, if in a given month there were six machines (or sets of machines) of which the standard hours were 200 per month at $10 per hour, the total cost of manufacturing capacity would be

200 hr × $10 × 6 = $12,000 for 1,200 hr

And if in a given month production fell short by 400 hr which led to the reduction of service to the extent of $500, the results would be presented as follows

Actual production, 800 hr @ $10	$8,000
Wasted capacity, 400 hr @ $10	4,000
Less economies effected	500
Net loss	$3,500

If, on the other hand, this wasted capacity were due to inefficient management, that is to say, to idleness of individual machines part of the time while the nominal working hours of the plant were still 200 per month, the idleness being distributed a few hours at this machine and a few hours at that, then it is probable that no economies could be effected The various services would have to be maintained at full stretch, even though much of them were running to waste The results would then have to be presented as follows

Actual production, 800 hr @ $10	$8,000
Loss due to idle machines	
400 hr @ $10	4,000
Economies	none

Relation of Wasted Capacity to Standard Cost—It will have been seen that the inefficiency discussed here is altogether of a different nature to that discussed in Chap X In that chapter we considered cost from the viewpoint of a standard time of operation and a standard wage rate It was found that variations were of two kinds (1) a longer or shorter time of operation might ensue, and (2) a higher or lower wage rate might be employed Now, in regard to process rates, we have also two

different kinds of efficiency to note The *standard process cost will be affected by one and not by the other*

As regards the cost of processing, there can be only one variable, provided that the work is done on the production center indicated, since the hourly processing *rate* is fixed But it is possible for the standard *time* of processing to vary from standard, in which case the cost of processing will be more or less than standard The other kind of inefficiency, namely, waste of manufacturing capacity due to idleness of delivery points, does not affect the cost of processing the job, but, as already explained, is to be regarded as a loss and charged ultimately to profit and loss

Combined Variations in Wage Cost and Process Cost —The case of a job standardized as to time, wage rate and process rate may now be considered from the viewpoint of the effect of variations on total cost

A single-department plant will be assumed with one delivery point, that is, only one stream of product, which delivery point has an hourly rate of $10, representing the service cost of the entire chain of processes that culminate at such delivery point The aggregate of wage rates on the chain of processes amounts to $4 per hour The standardized cost of a certain job may then be stated as follows

Time of processing	25 hr
Standard wage cost, 25 × $4	$100
Standard process cost, 25 × $10	250
Total cost of processing	$350

It may be assumed that when the job was put in hand on this occasion a rise in wages had taken place (namely, to $5 per hour) since the standard was fixed Also, that instead of the job being processed in 25 hr, 30 hr were consumed on it The results will be stated thus

	Standard	Actual	Ratio
Time taken on the job, hours	25	30	100 120
Wage cost of job	(@ $4) $100	(@ $ 5) $150	100 150
Process cost of job	(@ $10) 250	(@ $10) $300	100 120
Total cost of job	$350	$450	100 128 5

The figures show an increased job cost of $100 This may be analyzed as to cause of variation, thus

		Ratio
Actual cost of job	$450	100 128½
Standard cost	350	
Excess over standard	$100	
Deduct excess due to higher wage rate (30 hr @ $1)	30	
Excess due to longer time	$ 70	

This excess due to longer time arises, of course, partly from wage cost and partly from process cost It is, therefore, analyzed further, thus

Wages, 5 hr @ $4	$20
Process, 5 hr @ $10	50
Excess due to longer time, 5 hr	$70

These excess amounts can be summarized

Excess over standard due to higher wage rate	$ 30
Excess over standard due to longer wage time	20
Excess over standard due to longer process time	50
Total excess over standard	$100

In considering these results and comparing them with standard cost, a decision as to whether the standard needed modification would be based on judgment as to which of these excesses were permanent and which were reducible to standard In this case it is probable that the increase due to rise in wages would be of a permanent character, and this would imply that the standardized cost should be increased by revision of that item The new standard cost would then become

Standard time	25 hr
Standard wage cost, 25 @ $5	$125
Standard process cost, 25 @ $10	250
New standard cost	$375

Conclusion —The general aim of standardization of service factors is, (by means of collecting all normal overhead into several groups of which the annual value is then worked out), to find the cost of the manufacturing capacity of the whole plant for one year This annual value is made up of some items that are divided by the standard number of working hours that has been fixed for the year and of other items that are multiplied by the standard hours The annual value being thus obtained, the hourly value is derived from simple division of the total by the working hours

This hourly value is the process rate representing one hour's manufacturing capacity of the whole plant, or, in other words, the cost of maintaining a state of preparedness to do work. This hourly rate is then the cost per hour *at which work can be done*.

Every delivery point has its own hourly process rate, but under the conditions here assumed, namely, that the whole plant is one department working on a homogeneous product, there can be no difference between such rates. They are arrived at by dividing the number of delivery points into the hourly rate for the whole plant.

In the usual course of operations it is possible that some delivery points will be idle part of the time. In this case, as described in Chap. VIII, the hourly expenditure incident at such points drips into a pool of waste. The delivery points past which product is flowing continue to charge cost with the standard hourly charge, irrespective of what other delivery points are doing.

In relation to standard process cost of a job, standardized hourly rates can provide only one variable. Either the job is performed in standard time or it is not. If it is, then standard process cost results. If more or less time is used, then process cost will be higher or lower.

Where direct wages are charged to a job separately from process rates (as is the usual course, though an alternative will be considered later), then three variables appear. Variation in time of processing may cause increase or decrease of both wage cost and process cost, and also a different rate of wages may have been employed from that called for by standard. The value of these three variations both in percentages and dollars and cents can be shown separately in the cost statement.

CHAPTER XIII

EFFECT OF CURTAILMENT OF PRODUCTION

Curtailed production may arise from two sources It may be deliberate, as when orders are scarce and it becomes necessary either to cut down the working day or to work fewer days per week, or it may be involuntary, as when, from one reason or another (the reason is of little importance in this connection), some or all of the delivery points are idle when they should be working Of the two cases, the former is, of course, the more important, as dealing with larger values, but the latter is also very often much larger than anyone believes It will be necessary, however, to consider each case in considerable detail, so as to determine what really happens to costs and to profits in either instance

How Far Process Rates Apply —The first and most interesting point will be the discussion of how far, under the circumstances both of deliberate and involuntary curtailment of production, our standardized process rates are to be considered applicable to the costing of product We are not concerned just now with a condition of *permanently* curtailed production, as in the case of a product the demand for which is no longer sufficient to make it worthwhile to maintain production at full A permanent curtailment of this kind is in the nature of a catastrophe and, obviously, puts an end to all current arrangements, which must be entirely revised and reorganized to meet the new conditions

The curtailment which is referred to here as being deliberate is assumed to be of a temporary character, that is, it is hoped that conditions will revert to normal within a longer or shorter period, and it must, therefore, be discussed as an unavoidable aberration from a normal condition

It will be the object of this chapter to demonstrate that under conditions of deliberate and involuntary curtailment of production the process rate itself is unaltered and is properly applied to output just as though full time were being worked

Process Rate as a Measure of Something —If we consider the essential nature of a process rate, which has been built up,

as explained in previous chapters, out of various service factors each of which is represented by a different amount of service, the reason why temporary aberrations from normal production do not disqualify such rate from being used for costing output, whether curtailment is deliberate or involuntary, will be seen

A process rate, from the principles of its construction, is a measure of the value of time, and the particular time of which it is the value is one hour of normal operation of a production center under full-time conditions But this is only one way of looking at it When normal conditions exist, the process rate is the measure of *actual* service, it represents a condition that is really present If it discharges $2 in 1 hr into the cost of a job being done, it is because the $2 are actually being expended, hour by hour, as the upkeep of that process Unless a serious error has been made in the calculation of service factors, it would be impossible to imagine that any other sum than $2 was being expended per hour as the upkeep of the production center Under full-time conditions, as assumed, if all the hourly process rates are aggregated and multiplied by the working hours, their total at the end of a week or month would coincide with the actual expenditure on "overhead" as shown by the financial books In this case, therefore, the process rate is a real and actual subdivision, based on time, of a real and actual expenditure

But in proportion as production is curtailed, it is obvious that a disturbance of some kind has entered into this perfectly fitted and balanced system The question then arises, if under such circumstances we retain $2 an hour as the process rate, what happens Are we introducing a fictitious measure to ascertain costs, and, if so, will this lead to a fictitious element being introduced into these costs?

The answer to these queries is that a process rate is not *only* a real and actual cost per hour under full conditions It is also a measure of the cost of manufacturing *capacity*, of the power *to do*, under normal and reproducible conditions We have, in fact, set up a measuring rod the value of which is quite independent of the continuance of the conditions on which it was based It is a measure of what *can* be done rather than of what actually is being done As long as the conditions under which it was fixed are reproducible, its value as a measure remains unimpaired

Reproducible Conditions—What, then, are these conditions that must be reproducible? Obviously, as the process rate is

100 per cent correct when shop operation is 100 per cent of maximum, then the condition toward which we must struggle is that of full-time operation of all the production centers in a shop But this condition is precisely that which it is the aim of business operations, and particularly that of the selling department, to maintain If then, we are bidding on a job and making use of process rates for the purpose of estimating cost of production, what kind of rates would we naturally choose, if there were a choice? Surely those which obtain when full time is being worked, because that is the condition we wish to bring about by the bid

To test this proposition let it be supposed that under short-time conditions new process rates had been calculated, so that all service factors were taken up by the shortened number of working hours in a new and higher rate If this were, say, $2 50 instead of $2, what would result if we made use of this increased rate in bidding? Obviously, the estimate would be increased also It would now represent *not* the cost at which the work could be done when the shop resumed full time but a higher cost Apart from the fact that such an estimate would probably fail to be turned into an order, it is evident that our modified process rate has resulted in an estimated cost that has no relation to the cost at which work *can be done*, but only to that at which it would be done under one accidental and temporary condition of short-time working

Actual Process Cost under Varied Conditions—It may be objected that the foregoing argument has to do with estimating or bidding and not to actual costing of a job We may then consider the application to costing under varying conditions First, when working hours are 100 per cent of maximum, the process rate, say $2 an hour, is obviously correct, for the reason stated above Now, let it be supposed that we have a condition in which some 10 per cent of the total normal working time is producing no work, through idleness of delivery points

This would probably be an involuntary curtailment, and would involve little or no alteration in the cost or amount of service required to keep the shop moving Separation of wasted capacity from utilized capacity, as outlined in previous chapters, gives us a picture of certain delivery points from which service cost is being discharged on to jobs, and others from which, being idle, service cost is dripping into a pool of waste In this case there

are no economies of service to consider Charges to the shop burden account are the same, and these charges are being guided by process rates either to jobs or to waste Charges and credits being unchanged by reason of the curtailment, all we need note is the division into wasted and utilized capacity The process rates themselves are obviously unaffected and are functioning normally

It is a somewhat different matter when we have to consider the second case, namely, that of deliberate curtailment of production, which we may assume amounts to 25 per cent in a given shop Such curtailment may take one of two forms, either shorter working hours per day or fewer days per week Both of these conditions have similar effect, as either of them will permit economies in service

1 *Shorter Working Time* —It is one of the tragedies of manufacturing that cost of service cannot be cut down to anything like the same extent as can the cost of direct labor Service is a matter of organization, and usually any attempt greatly to reduce its cost means the impairment of its efficiency not only at the moment but also later when full time is restored More than this, there is a certain limit below which service cost cannot be reduced at all, unless the plant is shut down altogether These unfortunate facts are well known and need not be enlarged upon here All we are concerned with at present is the influence of a reduction of service cost, under short-time conditions, on process cost

We may assume that while production has been reduced 25 per cent it has been possible, by severe economies, to reduce service cost 15 per cent

2 *Repairs* —It should be noted, however, that all reduction of current expenditure does not imply reduction of service In the case of repairs, which enter into several factors, a certain annual total is arrived at, expenditure on which is distributed through the twelve months of the year Unless curtailment of production existed over a considerable fraction of the year, it is not probable that the necessity for such repairs would be greatly diminished But on the other hand the current expenditure on repairs in a time of depressed trade might be cut off entirely as a matter of financial urgency This would imply, if the item of repairs has been correctly allowed in the service factors, that on resuming full-time working the interruption in repair work would have to be made up by increased activity in this direction

In other words, expenditure on this item of service cost, though cut off for the moment, must be regarded as merely postponed to a more convenient season, not as having been evaded altogether as an item of expenditure

3 *Salaries* —Unless the depression is very severe, no great decrease in salaries may be expected Some part of the clerical force may be retrenched, and, in severe depressions, salaries themselves may be subjected to a cut, but in ordinary short-time conditions, when the depression is not expected to last very long, the general tendency is to preserve the organization unimpaired as far as possible No very considerable reduction is then possible under this head

4 *Interest, Depreciation, Insurance, Taxes* —All these items are annual and do not diminish, that is, they are not subject to reduction on account of shorter working hours

5 *Hourly Labor* —A good deal of service cost is made up of so-called "indirect labor" Consequently, if services are curtailed some of this can be laid off Less cleaning would be done, fewer firemen and laborers would be wanted in the power house, the number of helpers in stores, transport men, etc , would be cut down, possibly some subforemen would return to the bench or machine, and so forth In this class the most important reductions would be made

6 *Service Materials* —Beyond economies effected in the smaller varieties of material, such as oil, waste, etc , a certain economy might be expected in the power factor by reason of a lessened consumption of fuel Materials used on repairs would be reduced, but the remarks made above on the subject of repairs apply to material as well as to labor employed on repair activities

7 *Electricity* —If power were obtained from public supply mains, the question of economies might rest on the nature of the contract If an open one, current being purchased as and when used, then economies could be made But if a given total of kilowatts had been contracted for, and the normal consumption of the plant did not pass this total, then a lessened consumption would not yield any economies, since the contracted number of kilowatts would have to be paid for whether used or not

8 *Effect of Combined Economies* —If the foregoing are combined, it will be seen that it is quite impossible to reduce expenditure in anything like the proportion of reduced hours Certain items are not reducible at all, others only slightly, so that even

though the remainder were reducible in proportion to shortened working time, the combined effect would be much less

Significance of Reduced Expenditures.—If the reduction of working hours amounted to 25 per cent and the reduction of service costs to 15 per cent, it may be asked how far this reduction of expenditure affects process rates. The nominal total or aggregate of all process rates remaining the same, and the services represented by them having been reduced in amount, how far are the process rates themselves subject to reduction or alteration on this account?

Process rates are wholly unaffected, because they still represent the cost of what capacity to produce remains. If, with a *reduced* expenditure all machines were still operated to 100 per cent of standard working hours, then, of course, it would be obvious that actual conditions were no longer represented by existing process rates. If we have, for example, ten production centers, or delivery points, rated at $1 per hour and a normal working period of 200 hr. in a given month, the normal ingoings and outgoings could be stated, thus:

Normal cost of service (full time work)	$2,000	Charged to cost, 2,000 hr. @ $1	$2,000

Then, if as assumed above, working time were to be reduced 25 per cent and expenditures on service factors 15 per cent, the account would take this form:

Normal cost of service	$2,000	Actual working hours 1,500	
		Charge to cost, 1,500 hr.	
Less economies (15 per cent)	300	@ $1	$1,500
Present cost of service	$1,700	Balance	200
			$1,700

This balance ($200) represents the net drip to the pool of waste after all possible economies have been effected. From these figures it is obvious that the total loss due to failure to work the full 2,000 hr. would have been $500 and not $200 but for the fact that economies in service had been effected amounting to $300.

But if, when economies amounting to $300 had been effected, it were found that full working time had been worked, thus:

Cost of service	$2,000	Charge to cost, 2,000 hr.	
Less 15 per cent	300	@ $1	$2,000
Reduced cost of service	$1,700		

Then it would be obvious that something was wrong, inasmuch as $300 more has been charged into cost through process rates than was actually expended We should, in fact, be faced with a condition in which the original total capacity would exist and be applicable to production at a less cost than standard It would imply that process rates were calculated at too high a figure through more service having been allotted to production centers than was required to keep them in action 100 per cent of standard working time This would be a very unusual thing to happen

Example with One Factor—The relation of reduced service to reduced production can perhaps be studied more clearly by confining attention to a single factor, say the power factor

Hours	Charge	Prod center	Utilized	Wasted
1	$ 2 00	10 wkg @ 20 cts	$ 2 00	
2	2 00	8 " " " "	1 60	$0 40
3	2 00	10 " " " "	2 00	
4	2 00	10 " " " "	2 00	
5	2 00	Breakdown		2 00
6	2 00	8 wkg @ 20 cts	1 60	0 40
7	2 00	10 " " " "	2 00	
8	2 00	10 " " " "	2 00	
Total	$16 00		$13 20	$2 80

FIG 31 —Power factor utilized and wasted standard day (8 hr)

A case may be supposed in which the cost of power for a working day of 8 hr was $16, (Fig 31) and when, by reason of depression, the working day was temporarily reduced to 6 hours (Fig 32), the cost of power was found to be $13 98 per day There were 10 production centers or delivery points each rated at 20 cts an hour (power factor share of process rate)

In Fig 31 the proceedings of the day, hour by hour, for a standard day of 8 hr is shown In the first, third, fourth, seventh and eighth hours the whole of the 10 production centers were working In each of these hours, therefore, power to the value of $2 was consumed and charged into product through costs In the second and sixth hour, two of the centers were idle and only eight working In these hours, therefore, $1 60 worth of power was utilized and charged into costs and $0 40 worth wasted In the fifth hour a breakdown (*e g* , main motor, etc) took place, and service was not restored to the centers

for a whole hour Nevertheless, no reduced power generation in the power plant was feasible, as, from minute to minute, the breakdown was expected to terminate The charge for power was, therefore, the same as in other hours, but was wholly wasted, $2 is therefore charged in wasted column

In Fig 32 the condition of affairs when working hours had been reduced to 6 is shown The total expense for power for a 6-hr day was found to be $13 98 (instead of $16 for 8 hr) We are, therefore, at liberty to say that the cost of power for any single hour was $2 33

Though some saving has been effected in power generation owing to the shorter working day, it is not in proportion to the

Hour	Charge	Prod centers	Utilized	Wasted
1	2 33	10 wkg @ 20 cts	$2 00	$0 33
2	2 33	8 " " " "	1 60	0 73
3	2 33	10 " " " "	2 00	0 33
4	2 33	10 " " " "	2 00	0 33
5	2 33	Breakdown		2 33
6	2 33	10 wkg @ 20 cts	2 00	0 33
Total	$13 98		$9 60	$4 38

Fig 32 —Power factor, utilized and wasted short-time day (6 hr)

working hours in each case A smaller total charge for the day has resulted, it is true, but when this smaller total is divided by the shorter working time (6 hr) it is seen that the cost of power per unit (such as an hour's supply) is higher than normal The general effect of this is that a more wasteful condition exists

To return to Fig 32, we have 4 hr in which all 10 centers were at work In each of these hours the same amount as formerly ($2) is charged into cost through process rates, and the surplus cost per hour ($0 33) is charged to waste The reason for this must be fully understood

1 *Why* $2 *and Not* $2 33 *Is Charged to Production* —Here we have a case in which $2 33 is, as it were, proffered to us as the cost of power for an hour We accept $2 of it and reject $0 33 Why is this? The fundamental principle of process rates is here seen in action, and it can be usefully restated with this example in view

The $2 rate is the actual cost of power per hour for the 10 production centers in question when full or standard working

hours are in force It may be considered as having been vouched for and proved by actual conformity of service cost with service factors over a sufficient period This implies that it is a *reproducible* rate, whenever shop conditions correspond with normal It is, therefore, the rate at which work *can be done* And, if it is the cost at which work can be done, it must be the cost at which work *is being done* even though this true cost is masked by higher prices for service, due to such service being spread over fewer hours and not being reducible in proportion to such hours

But if \$2 is the cost at which work can be and is being done, then it must be inferred that the higher price of service is something separate and distinct from the cost of doing work, and this inference is confirmed by observing that such higher price *wanes and vanishes as normal working hours are attained again* The \$0 33, which was rejected as part of true cost, is, in fact, an arithmetical ratio and represents nothing but *a failure to save* a portion of the cost of service which would normally have been expended *on the seventh and eighth hour*

2 *Failure to Save* —This expression "failure to save or economize" is really the key to the existence of the \$0 33

If we were able to save all the cost of service beyond the short-time period of 6 hr, then the cost of 6 hr and of 8 hr would be the same *per hour* If the process rate were \$2 for the one, it must necessarily be a similar amount for the other This may be demonstrated by an example

In Figs 31 and 32 ten production centers are in question If under the normal conditions of an 8-hr day we find a charge of \$16 for power, this means (as each center is assumed to take an equal amount of power) a power rate of 20 cts per hour per machine

If under short-time conditions, when the working day is reduced to 6 hr, it were found possible to take up *all* the slack, so that the power supply for 6 hr amounted to \$12, this would mean \$2 per day, and this daily charge divided among ten machines would be 20 cts an hour, as before

This is just what would happen if power were being taken from the mains on an open contract and only such power as was actually consumed was paid for On an 8-hr basis there would be a charge of \$2 per hour, and a consequent rate of 20 cts On a 6-hr basis, \$2 per hour would again give a 20-ct rate

But for the two hours in which no work was done we should pay nothing at all In other words there would be no superfluous service to pay for

3 *Superfluous Service* —The thing which we have failed to save or economize may then be defined as the cost of superfluous service That is, the cost of such service as is still going on, *but which is beyond the needs of the production actually taking place* This service is not wanted for the purposes of production but, for one reason or another, it cannot be cut off Definitely, it is that portion or amount of service which is left when the total cost of production, as determined by process rates actually charged to jobs, is subtracted from the actual cost of service as shown by the financial books What is thus left over is so left because no use has been found for it It has, in fact, been dripping into the pool of waste

If a process rate is $2 an hour, and if production is reduced 25 per cent and service (as in the case of the power charge referred to above) is reduced 25 per cent also, then, obviously, the process remains unaltered at $2, because its shorter discharge into work will accumulate a credit that will exactly equal the cost of the shorter period of power service But if we cannot reduce service 25 per cent but, say, only 15 per cent, it is perfectly obvious that process work actually being done cannot be fairly visited with a higher cost (process rate) because we are obliged to allow more service to enter the shop than we require

What Becomes of Superfluous Service —The ultimate destination of the cost of superfluous service can be illustrated by reference to the case of the power supply taken from public mains, referred to above, as contrasted with the case wherein power is generated in the plant power house

In the first case, wherein the plant pays only for what it consumes, power is charged in strict proportion to consumption by production centers, and as each center consumes the same quantity *per hour* on a short-time day as on a normal day, there is no superfluity *as far as the plant is concerned* But this is obviously not all the story The cost of generating power at the public service station will certainly not be reduced pro rata as the plant demand for current ceases Even though short time takes the form of shutting down two days a week, it will not be possible for the power station to economize to the extent of the revenue it loses on those two days

What really happens when we open the main switch and so cut all loss on power for the day is that *the whole question of superfluous power is thereby shifted from the plant to the power station.* And, if as is fairly certain, the power station cannot economize to the extent of the lost revenue, then the net difference *must be charged to its profit and loss account.*

Now, in the other case, wherein power is generated in the plant's own power house, we have virtually the same series of happenings. When production centers cease working, we may picture the act of opening the switch as cutting off the loss on power from the shop and transferring it to the power house. If the latter, as is practically certain, cannot economize to the extent of the lost charges which it would have otherwise made to the shop, then the net difference is loss. But, of course, in this case as power house and shop are owned by the same business, the loss in question must go *against the profit and loss account of the business itself.*

In either case the procedure is the same. Production is charged as usual and at the normal rate for what it actually consumed on jobs, and the loss due to unconsumed power is transferred to someone's profit and loss account—either that of a public service company or that of the firm itself.

Application to Other Factors.—The power factor affords the most convenient demonstration of what happens when production is reduced, inasmuch as the idea of "cutting off" power is familiar to everyone, as is also the idea of such a service being supplied from an outside source. But that the same series of happenings takes place in regard to other factors will be understood when we consider that the *nature* of the service has nothing to do with its utilization or waste. Anything in the nature of a service that is measurable by time (process-rate hour) can obviously be treated in the same way, as regards its monetary value. It is true that in the case of power there is something like a physical difference between utilization and non-utilization. In the one case actual current is flowing through the mains and feeders, in the other the current does not enter the shop or the production center. A space factor does not at first sight seem to afford a parallel case, but for all practical purposes it actually does.

This is most easily seen if we consider a 6-hr. day. For the last 2 hr. of the normal 8-hr. day, the shop stands idle and silent. Yet the building is still there. Moreover it is still there in a

condition of readiness or *preparedness for production* This condition is the result of expenditures, partly made up of amounts such as interest, depreciation, insurance, taxation, etc , which are not in the slightest degree reduced because of the accidental circumstance that the shop is idle in the seventh and eighth hour Some slight reductions of expense may be made to meet the condition Hourly wages of sweepers and cleaners will be cut off In winter the hourly cost of light and heat may be reduced but much the greater part of the expenditure remains, or, in other words, exactly as in the case of power, economies cannot overtake expenditure

Thus we have *failed to save* just as with the power factor, and the idle building, standing ready for production but not being utilized for production, may be regarded as representing *superfluous service,* for which at the moment we can find no use The net loss on this superfluous service must find its way, as in the case of power, to profit and loss account

Application to Process Rates—If the principles of failure to save and of superfluous service are applicable to each of the service factors as has been shown, then it follows necessarily that they apply also to process rates as a class Process rates are only the arithmetical total of the service factors entering into the maintenance of processes, consequently, they must follow the law of the service factors themselves When a process stops working and no product is passing its delivery point, then any service proffered to it is a superfluous service, whether this takes the form of power, space, supervision or other service And the destination of all superfluous service is not cost of product but profit and loss account

Conclusion—It has been demonstrated in this chapter that when an hourly rate accurately represents the cost of a service or services per hour when the shop is running 100 per cent of its standard working hours, it also represents the cost of the same services *as consumed in production* when the shop is running less than 100 per cent of standard working hours

Under short-time conditions it is possible for the cost of the power service to be entirely cut off, and, when this can be done, then the hourly power charge to such centers as are working will necessarily be unchanged on any possible theory But in this case the saving of the loss on lessened service is transferred to the public service station

Where the plant has its own power house, a similar loss, though eliminated from production centers, must be met within the business It may be considered as transferred to the power house, and this means that eventually it will be charged up to the profit and loss account of the business It is more usual, however, to consider that it is charged to profit and loss from the department concerned This is merely a matter of accounting convenience and does not affect the principle

Finally, the effect of curtailment of production may be stated as follows

1 Process rates remain unaltered, whether the shop is working 100 per cent of standard working hours or any less number of hours

2 When the curtailment of production is small and involuntary, production centers being idle half-an-hour here and half-an-hour there, there is usually no corresponding saving in service The cost of services remains the same as though all delivery points were giving 100 per cent delivery of product Under these conditions there is merely a division of results into "utilized capacity," which is charged to jobs, and "wasted capacity," which drip into the pool of waste from the delivery points of such production centers as are idle at any moment

3 When curtailment of production is official, based on fewer working hours per day or fewer days per week, then savings or economies in service will usually be possible, but these savings will not overtake the loss due to the shorter working periods

4 Under these short-time conditions there will be two varieties of loss First, the ordinary wasted capacity, due to individual production centers being idle during the new working hours, and, second, the cost of "superfluous service," namely, that portion of service in excess of the current needs of production which cannot be cut off or reduced

5 The ultimate destination of both wasted capacity and superfluous service is the profit and loss account

CHAPTER XIV

EFFECT OF INCREASED PRODUCTION OVERTIME

Like curtailment of production, overtime may arise from more than one cause. Perhaps the most frequent case is where it is called for on a few days toward the end of the month in order to bring up output to schedule, or to get out some specially important or urgent orders.

In other instances overtime may be worked steadily for a more or less lengthened period as a matter of deliberate policy. These two varieties of overtime are not exactly the same as regards the incidence of burden. Where overtime is worked week in and week out, it amounts to the setting up of a new standard of working hours, unless it has been foreseen and taken into account when the service factors and process rate were being fixed.

Effect of Overtime in General.—Before considering these two varieties in detail, the general aspect of the overtime question in relation to cost may be examined. Overtime has, of course, an exactly opposite effect to that of curtailment. Annual charges are, as it were, spread thinner. Instead of being divisible by, say, 2,400 hr., they may be divisible by 2,800 hr. in the year. Hourly charges, on the contrary, tend to increase in direct proportion to the amount of overtime worked. The problem is also the exact opposite of curtailment in the respect that there is no running ahead of service cost over production. On the contrary, *from a process cost viewpoint*, overtime tends sometimes rather to an apparent increased efficiency than to a diminished efficiency.

This follows from the nature of the conventions we set up when standardizing factors and rates. A certain annual total is arrived at, which represents the annual cost of manufacturing capacity for an assigned number of hours in the year. Overtime tends to increase this number of hours, and, therefore, to lower the amount per hour. This new and lower hourly rate is, however, not realizable by simply dividing the annual amount by the increased total of hours, inasmuch as certain items of hourly service increase along with the increased working time. The

true amount per hour is, therefore, always something more than would be found by a straight division of annual amounts.

In the case of curtailment of production, the principal effort was directed to cut down service cost as much as possible by eliminating such hourly service jobs as could be dispensed with, even though with inconvenience. In the case of overtime, the principal attention is given to preventing increase of hourly labor items beyond normal, which is, of course, a much easier task.

Process Cost Relation to Overtime.—Thus, from the viewpoint of process cost *alone*, overtime presents no very alarming problem. In industries wherein machinery is heavy and costly, consuming much power and occupying considerable space, the more overtime is worked the greater is process cost efficiency. The confirmation of this statement may be found in the consideration that process cost necessarily diminishes from an 8 hr. day to a 16-hr. day and is at its minimum in a 24-hr. day, that is, when three shifts are continuously employed. While these efficiencies are not proportionate, inasmuch as, to cite one example, depreciation for a 24-hr. day would be more than that for a 16-hr. day and considerably more than that for 8 hr., still, on the whole, it may be said that the thinning out of the annual charges tends to give a lower process rate the longer the working hours up to the maximum of 24 hr. per day.

Effect of Temporary Overtime.—If in a certain shop all production centers have operated 100 per cent and the working hours for the month have been 220 instead of the standard 200, thus having operated during 10 per cent of overtime, then, when the shop burden account is made up at the month-end, there will probably be a balance in it which will represent a *credit* to profit and loss. This, of course, is the precise opposite of what happens when production is curtailed. In that case there always will be a balance in burden account which is a charge, or debit, to profit and loss.

Standard factors	$2 000	Charged to job 2,000 hr. @ $1	$2 000

FIG. 33.—Burden account no overtime. Production 100 per cent.

Figure 33 shows normal conditions. Production centers having worked 100 per cent of standard time, the factor charges are met exactly by the charges to jobs. Consequently, there is no balance in burden account.

Figure 34 shows the position when overtime to the extent of 10 per cent has been worked during the month. The same standard factor charges are applicable, but additional to these there are certain extra hourly services, transport men, laborers, firemen, engineers, and so forth, which have been found necessary. The extra cost of those items was $75. The amount charged into costs will, however, have been $2,200 (instead of $2,000) and this will be $125 *more* than the standard service charges ($2,000) plus the new hourly charges ($75). This $125 is *overdistributed* service charge and, as before remarked, becomes a credit to profit and loss account.

Standard factors Additional service Bal. credit to P. & L.	$2,000 75 125	Charged to job 2,200 hr. @ $1	$2,200
Total	$2,200		$2,200

FIG. 34.—Burden account. 10 per cent overtime. Production 100 per cent of possible time.

Nature of the Overdistributed Amount.—It is somewhat important to understand just what this $125 overdistributed represents. Without going into great detail, its nature may be inferred from what was actually done to make up the left-hand side of the account. First was charged the normal factor charge for 2,000 hr. As production centers were considered as having been at work 100 per cent of full time, this normal charge represents the normal cost of the *first* 2,000 hr. worked. Then, on account of the *additional* 200 hr. it was found that actual debits were $75 above normal. It is obvious that this $75 is added to items *of like class* in the normal factor charge, representing increased activity in those items.

From this we may infer that it is not items of this class (hourly service items) that are overdistributed, since, as a matter of fact, we had to add more of them. The amount ($125), still overdistributed, must represent the thinning out of annual charges, which, instead of being spread over 2,000 hr., are now spread over 2,200. And, as we have distributed on the basis of 2,000 hr. through process rates, $125 worth of annual charges have been overdistributed.

This can be more readily seen if actual figures are studied. Let it be assumed that the $2,000 service-factor charge was,

in fact, made up of annual and hourly charges in the following proportions

Annual charges	$1,250
Hourly charges	750
Total	$2,000

When 10 per cent overtime has been worked and the standard process rate of $1 per hour has been maintained, the results will be as shown in Fig 35 When the first 2,000 hr has been worked, if the shop were shut down there would be no difference between this month and any normal month But in keeping up production for another 200 hr (overtime), we have, on the one hand, *no more* annual expense to be charged, as the whole share for the

	Normal conditions	Overtime conditions		
		First	Overtime	Total
Hours	2,000	2,000	200	2 200
Annual	$1,250	$1,250	$\boxed{\$125}$	$1,375
Hourly	750	750	75	825
Total	$2 000	$2 000	$200	$2,200

NOTE —The amount $\boxed{\$125}$ is a credit

FIG 35 —How overdistribution is made up

month has already been charged against the first 2,000 hr , on the other hand, the continued charging into costs of the process rate for the additional 200 hr results in a charge to production of $125 more annual charges than we have any value to charge It is precisely this $125 that appears as a credit to profit and loss in the burden account above Fig 34 and is derived from a 10 per cent addition to the $1,250 which is the normal annual charge for the month The $75 is the amount paid out for additional hourly services

Significance of This Overdistribution —The problem has to be regarded from two aspects First, as to the correctness of costs, and, second, as to justification of the credit to profit and loss The viewpoint of our examination will be that of how far these proceedings reflect the facts of production

1 *Why Process Rate Is Maintained Unchanged* —It will have been observed that, in the examples given above, the amounts charged to jobs by way of process rates are unaffected The standard process rate is charged both in the ordinary period and also in the overtime period One reason for this is that, whether the cost of processing during overtime hours be greater or lesser than at other times, the individual job should not bear the burden of this variation of cost If the normal day is 8 hr and the overtime day 11 hr , it would be absurd to say that a job done in 3 hr cost more (or less) if done in the first 3 hr than in the middle 3 or the last 3 In other words, individual jobs must not be penalized because they happen to have been worked on in an overtime period

Moreover, the object to be attained is the costing of product at standard, and the transference of inefficiencies that may arise from unusual or temporary conditions to special accounts and so ultimately to profit and loss If it is proper to do this under circumstances (curtailed production) where the amounts so removed from cost proper are heavy, it is at least equally appropriate to cost product at standard process costs under circumstances (overtime) where the amounts are small and in the opposite direction The true cost of processing is the same under all conditions, and the maintenance of the standard process rate serves to separate out charges due to exceptional conditions and keep them out of true cost

2 *Credit to Profit and Loss* —The balance in burden account consists, as has been shown, of the difference between actual annual charges chargeable to the shop in the month, and that portion of the process rate which represents annual charges, which latter have been charged for 220 hr instead of 200 hr What fact of production does this amount represent? By virtue of a temporary and unforeseen condition we have made *an economy* in annual charges After charging production at standard process rates we have found something over We may regard this as a temporary and accidental superefficiency, like in character but opposite in sign to the infraefficiency which results when some accidental and temporary condition leads to increased expenditure over standard As the latter is chargeable, not against the jobs which happen to be running through the shop but to profit and loss, so, likewise, the advantage arising from this supereffi-

ciency (which is anyway only a bookkeeping superefficiency) is properly applied to relieve profit and loss

3 *Magnitude of the Items Involved* —If we assume that there are 2,400 working hours in the standard year, then 1 hr will be *one twenty-four-hundredth* of the annual value, and, if the annual charges are 50 per cent of the total, then the annual charges portion will be *one forty-eight-hundredth* Similarly, if in a given month overtime to the extent of 10 per cent is worked, that is, 20 hr over the normal 200, then the full hourly rates concerned will be less than *one per cent* of total annual value, and the annual charges portion will be less than one-half of 1 per cent The relief to profit and loss account by reason of a moderate of overtime being charged into cost at standard process rates will be very small, and, in general, may be ignored as affecting accuracy of the accounting even though the view is held that actual costs of jobs should be credited

Diagram of Overtime Relations —The foregoing paragraphs on the relations between annual and hourly charges as compo-

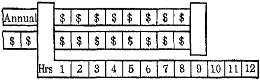


FIG 36

nents of the process rates may be illustrated diagrammatically In Fig 36 an imaginary sliding scale is shown The single bar, inscribed with hours, is considered the fixed member, and the upper portion, consisting of two bars attached to a common upright, is the movable member In the position shown in the figure, the standard day of 8 hr is the period for which the scale is set Each of the hours has above it x\$ for annual charge and x\$ for hourly charge If we consider each x as \$1, then the combined amounts will be \$2 per hour for each and every hour of the working 8 hr

1 *Effect of Overtime* —In Fig 36*a* the movable member has been drawn out to the right, so that now the space between the two uprights represents 11 hr, that is, 3 hr overtime are being worked The way in which annual charges behave as contrasted with hourly charges is very clearly shown by the

fact that, while the latter increase pro rata with the working hours, *no more* dollar ($) signs (representing *annual* charges) are present on the upper scale than before. The act of extending working hours has brought into the working field more dollar signs representing hourly charges, but the signs representing annual charges are unaffected. The white space to the left on the upper bar is not, of course, actually connected in any way with the first 3 hr., but the dollar signs on that bar may be con-

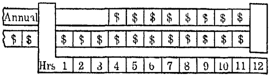


FIG. 36a

sidered as now spaced equally. The general effect of extension of working hours is thus seen to be a *smaller cost per hour*, since the total day's charges are in the proportion of 16 : 8 in Fig. 36 and in the proportion of only 19 : 11 in Fig. 36a.

2. *Effect of Standard Process Rate.*—In Fig. 36b we have the same conditions as in Fig. 36a, but the situation will now be discussed from the viewpoint of jobs being charged at standard process rates. If we assume that one job per hour is being

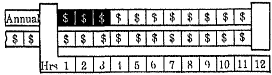


FIG. 36b

worked on, that is, the process in question takes an exact hour to complete one job, then it will be seen that in hours 4 to 11 perfectly normal charges to jobs are taking place. Each hour is chargeable with $1 + $1 = $2. But in the case of the first 3 hr., it will be seen that the dollar sign is white on a black ground, and that these white signs occupy the position which was blank in Fig. 36a. What do we intend to signify by this symbolism?

In Fig. 36 the normal working day of 8 hr. was shown. The dollar signs on the upper and lower movable bars then represent

not only the actual incidence of the two varieties of overhead on hours but also the incidence of the standard process rate, since this corresponds with normal conditions. Now, returning to Fig. 36*b*, if we apply the normal process rate to each hour, the results will correspond exactly with the dollar signs in hours 4 to 11, and, if applied to hours 1 to 3, an exactly similar result will follow, since process rate contains $1 of annual and $1 of hourly charge in its composition. The white symbols represent, then, a charge to jobs through process rate of *an amount which was not actually expended*. This amount, as described above, is what is credited to profit and loss as representing a saving or economy due to overtime production.

Economy in Annual Charges May Be Neutralized.—While this process of thinning out annual charges during overtime is important to understand, in practice it may not actually lead to a credit to profit and loss account. In most cases, today, overtime labor is paid for at increased rates, and this applies not merely to direct labor but to all labor, including that which is providing service. This would mean, referring again to Fig. 36, etc., that the lower movable bar in 36*a* and 36*b* would be increased in *value*. The dollar signs on that bar would represent $1.25 or $1.50 instead of $1, and this would very quickly overpower or even reverse the total effect. As the process rate charges only $1 for hourly charges per hour, a surplus of, say, 25 cts. per hour would be left undistributed and this would, of course, be a charge to profit and loss. But combined with the credit arising from the three white symbols, the total effect might be practically neutral. The net result would provide neither a credit nor a charge to profit and loss, or only an insignificant one. In such cases actual expenditure and process rate charges would be almost identical again, though the grounds of agreement would be quite other than those of normal working. The practical results is the same but the method of arriving very different.

Significance of This Coincidence.—The user of a system of costs, based on process rates, who was not familiar with the principles of the method would be very apt, on finding that his process rates were distributing burden as closely under overtime conditions as under normal conditions, to think that this was due to some singular faculty of adaptation of the process rate to diverse conditions. If educated under the old theories of burden distribution, it is possible that he would find great comfort and

satisfaction in finding his burden charges thus, as it were, mopped up and charged to jobs without leaving any balance to go elsewhere

Actually, however, such a coincidence is purely accidental and does not arise from any inherent principle It is no virtue of the process rate that would give rise to such a result The process rate, on the contrary, goes steadily on its way, costing each job at standard cost, but it so happens, in the special conditions outlined above, that savings in one item are closely balanced by losses in another, so that when all is counted up, there is nothing left to be transferred elsewhere What has been gained by thinning out annual charges has been lost again by higher rate of pay for overtime labor on service The true cost of the job has nothing to do with either of these accidental amounts, and should they neutralize each other or should one of them preponderate is a matter of no significance whatever from the viewpoint of true cost of jobs

Overtime of a More Permanent Character —Hitherto we have been regarding the question of overtime as being a temporary condition due to some unexpected pressure on production It has been shown that a credit to profit and loss due to the thinning out of annual charges takes place, but that this may be partially or wholly neutralized by the increased rate of pay to service workers when overtime is worked We have now to consider the case where overtime is part of the settled policy of the concern, either due to seasonal pressure or to the acceptance of a large contract, to the carrying out of which the normal output of the plant is inadequate In this latter connection we have also to consider the question of bidding or estimating, and what process rates should be used to secure such a contract

A long-continued period of overtime is equivalent to the setting up of a longer working year If, during 3 months every year, it is foreseen that 10 per cent overtime will be worked, then the calculation of service factors will proceed on this understanding, and the annual total of each factor, instead of being divided into 2,400 hr amounts, will be divided by, say, 2,460, thus including 3 months in which working hours will be 220 instead of 200 If this is properly carried out, then complete distribution of all normal burden should be effected each month, provided production centers were working 100 per cent of the allotted or standard hours

Process Rates Based on Overtime Working—How far process rates set up on this understanding will differ from those which would have resulted if only a normal 2,400-hr year had been figured on will depend entirely upon local circumstances, particularly on the proportion of annual to hourly charges in the rate In general the influence of the thinning out of the annual charges, particularly where large, costly and heavy machinery is in question, should more than counterbalance the increased cost due to extra rates of pay for overtime No rule can be laid down, and only actual setting up of service factors will determine the relative amount of process rates under the two sets of conditions

Example of Year's Working with Overtime—The influence of considerable overtime on process rates can be more readily understood if an example in actual figures is studied We may suppose a certain shop in which last year 2,400 hr were worked and in which any particular service factor amounted to $2,400 This gives a process rate (or rather a factor rate) of $1 per hour Now, in the coming year it is intended to take up a line of work which will necessitate working 20 per cent overtime in the first two quarters of the year The question then arises How will this affect the rate?

Figure 37*a* presents the ordinary conditions without overtime In each quarter 600 hr are worked, and in each such quarter the

Quarter	1	2	3	4	Year
Working hours	600	600	600	600	2 400
Annual charges	$300	$300	$300	$300	$1,200
Hourly charges	300	300	300	300	1,200
Total factor	$600	$600	$600	$600	$2,400

FIG 37*a*—Year's operation without overtime

service in question costs $600, the factor being composed half of annual and half of hourly services The resulting factor rate would be $1 per hour

In Fig 37*b* the first two quarters show a total of working hours of 720, the remaining quarters 600 hr as before The annual charge ($1,200) is, therefore, now divisible over 2,640 instead of 2,400 hr, while the hourly charge increases in some proportion to the working hours This leaves the service factor at $687 for

the quarters in which overtime is worked, while the other quarters stand at $573 The new and higher total for the year ($2,520 instead of $2,400) when divided by the new working hours (2,640) gives a new factor rate of about $0 955

The new rate represents, of course, the combined effect of an increase in the amount of hourly service to the extent of 240 overtime hours with the thinning out of the incidence of the annual charges, which are now spread over 240 hr more than in

Quarter	1	2	3	4	Year
Working hours	720	720	600	600	2,640
Annual charges	$327	$327	$273	$273	$1 200
Hourly charges	360	360	300	300	1 320
Total factor	$687	$687	$573	$573	$2,520

FIG 37b —Year's operation with deliberate overtime

the first instance The net effect is a rate of $0 955 per hour instead of $1

Moreover, this new rate, if applied quarter by quarter to production, yields a sum that entirely clears up the service charges for that quarter This is shown by Fig 37c wherein the new rate multiplied by 720 hr for the overtime quarters gives a charge to production and a credit to burden of $687, and in the non-overtime quarters $573 in each quarter By comparing Fig 37c with the bottom line in Fig 37b it will be seen that these sums exactly equal the service charges for the respective quarters

Hours @ $0 955	$687	$687	$573	$573	$2,520

FIG 37c —Yield of new process rate, by quarters

While, for simplicity, it has been assumed in the above illustrations that only one factor is concerned, exactly the same results would, of course, follow if the complete process rate were studied The latter is merely the arithmetical total of several factor rates, and what is true of the part is also true of the whole Further, while we have spoken of a "shop" in relation to the charges and credits, which would imply a single department with only one delivery point, the argument applies equally to subdivisions of such a shop, namely, to the individual production

centers if there should happen to be such In this case what is true of the whole is also true of each part

Estimating on Work Involving Continuous Overtime —It will now be seen that, where carefully budgeted service factors are in operation, it becomes a comparatively simple matter to ascertain process costs under any particular set of conditions that may be postulated If, for example, it were a question of bidding on a long-term contract which would necessitate overtime over several months, then, as demonstrated by Figs 37*a*, 37*b* and 37*c*, the process rates applicable to the work could be calculated in advance, and any guesswork as to the outcome of overtime conditions ascertained before the bid was made In this particular case a reduction of nearly 4 cts per hour was shown, but, as before mentioned, this would be increased or diminished according as the annual charges preponderated or not

In making such calculations of cost the question of increased rates of pay for direct labor would, of course, also be taken into consideration, but, as we are here dealing only with process cost, that is, with what is usually termed "overhead," this aspect of bidding or estimating cannot be discussed further

Double and Treble Shift Working —These differ from ordinary overtime not only in degree Annual charges are spread out thinner, but some of them, such as depreciation and repair, would be subject to considerable increase Where either double or treble shifts are worked, particularly the latter, a wholly new set of conditions is created, and the factor budgets made up for normal or moderate overtime working no longer apply On the other hand, there is no special difficulty in making up new service-factor budgets covering the new conditions and in settling new process rates in correspondence Such process rates would, generally, be lower than those set up for normal working How much lower depends on local circumstances in each case

Conclusion —The essential feature of overtime as it affects process cost is the thinning out of annual charges, such as interest, depreciation, insurance, taxes, salaries, repairs, etc , in their incidence on working hours This reduced incidence tends to a lower process cost, but, on the other hand, the saving (per hour) on annual charges may be masked by increased rates of pay to hourly workers (service workers) during the overtime hours

Where overtime is a considerable feature, new process rates should be set up, but short and sporadic periods of overtime

do not require this. The small saving on annual charges is passed as a credit to profit and loss, where it may be considered to offset inefficiences in other months.

Double- and treble-shift working demand, on the other hand, the most careful survey and budgeting of service factors to represent such conditions. Not only hourly services will be increased but also certain of the annual charges themselves will be higher under such conditions. Each type of working will necessarily have a different set of process rates.

Process rates represent, at all times, standard conditions. It is evident, therefore, that when any considerable change takes place in such conditions, as when considerable overtime or double and treble shifts are being worked, the amounts contained in each service factor will be affected, and the old ones will no longer be representative of what is taking place. New factors and rates do not, however, present any difficulty, nor does it take very much time to recast them in accordance with the new facts.

In general, whenever overtime can be foreseen, it should be included in the annual total of working hours.

CHAPTER XV

SEASONAL OPERATION

In some industries the possession of a fully equipped factory does not necessarily imply that it can be operated at all times Where a plant is equipped, for example, to handle the packing of some particular crop, a supply of the crop is just as essential as the possession of the plant And it may happen that such supplies are forthcoming only in a certain limited period of the year

In many plants of this character the distribution of working hours throughout the year is apt to be very irregular At certain times production will be pushed to the limit with double shifts, or possibly 24-hr working At other times the plant will be running but a few hours a day, or a few days per week And during several months it may possibly be entirely shut down to await the coming of next season's crop

Two Varieties of Seasonal Plant—The foregoing type of plant is one in which, by reason of highly specialized equipment, it is impossible to expect any other utilization of the plant in the off seasons But a second type also exists wherein, although the product actually being made has a marked seasonal period, it is possible that other products might be produced with the same equipment in the slack seasons As the process costs of these two types demand different treatment, the first or purely seasonal type will be discussed first

Production of Purely Seasonal Type—From what has been said above it will be understood that we are now facing altogether different conditions from any we have as yet met Hitherto it has been assumed that if a plant has a normal 50-hr week, the plant will be running 50 hr in each and every week of the year, with the exception of such weeks as happen to include public holidays Failure to run such 50 hr is to be considered as a departure from efficiency, and our standardization is based on just this consideration In ordinary manufacturing this view is justifiable If enough business cannot be obtained to keep the plant running 100 per cent of its standard working hours,

loss ensues The cost of what is actually made does not increase, but the expenditure for superfluous service that takes place over and above this standard cost is wholly wasted and is chargeable to profit and loss If a condition of inefficiency of the kind exists, it is to be regarded as a temporary misfortune If it proved to be permanent, the plant would probably have to go out of business

But, in the kind of business we are now considering, a wholly different fundamental condition exists The limits of production are set not by the equipment alone but by the equipment plus the supply of raw material The output of goods at the period of maximum pressure is limited, of course, by the equipment, but at all other times the limiting condition is that of the supply of material This may arise because of the fact that crops cannot be gathered or fish caught at all seasons of the year, and that their arrival on the market varies both as to dates and quantities

In a few cases the limiting condition is not the supply of material but a highly spasmodic *demand* resting on weather conditions or other unforeseeable circumstances

The *reasons* for seasonal working are not, however, of much importance compared with the facts Instead of having a fairly uniform production throughout the working year, violent fluctuations are forced upon us, varying from perhaps double-shift working in the busiest season to complete closing down in the slackest months As these conditions are in the nature of the industry, they must be recognized in whatever mechanism for the settling of standard cost we elect to set up

Standards in Seasonal Operation—On the very slippery ground provided by seasonal operation, the erection of standards must be effected by other means than those applicable in ordinary manufacturing The first standard will be that of the annual output, and our subsequent operations must be based on this rather than on any question of manufacturing *capacity* It usually will be possible to set up a reasonable standard for the quantity of output during a coming season, based on experience in the industry This quantity, the rate of processing being known, can then be expressed in terms of so many working hours in the year

The next step is to distribute these working hours over the months in which the plant will be operated This also is a

matter for experience to decide While the distribution of working hours is often a matter that cannot be controlled, as it depends on market conditions of raw material, a fair and reasonable forecast usually can be made

Having now set up a schedule of working hours, it only remains to set up a corresponding schedule of service factors, consisting, as usual, of two main classes of expenditure, namely, that which is annual and that which is hourly

In setting up service factors the expenditure on hourly service in the periods of maximum production will be very carefully observed and budgeted before proceeding to the examination of the remaining periods

The Working Year —The annual manufacturing capacity, as has already been remarked, will be distributed very irregularly throughout the different months There will be, frequently, a period of very high pressure, preceded and followed by periods of less pressure, and at other periods the plant may be closed down altogether, thus (Fig 38)

Month	1	2	3	4	5	6	7	8	9	10	11	12	Total
Working hours				200	300	400	400	300	200				1,800

FIG 38 —Distribution of working hours

The activity of the plant being confined to six months, it will be evident that any expenses incurred in the first three and the last three of the year *must form part of the annual charges* which must be incident on the six months which are active

When all service factors have been set up, we may consider that process rates (assuming a simple plant with only one delivery point) are constituted thus (Fig 39)

Month	4	5	6	7	8	9	Total
Annual charges	$400	$ 600	$ 800	$ 800	$ 600	$400	$3,600
Hourly charges	300	450	600	600	450	300	$2,700
Total factor	$700	$1,050	$1,400	$1,400	$1,050	$700	$6,300

FIG 39 —Distribution of service charges

The total of all service factors ($6,300) divided by total of working hours (1,800) gives an hourly process rate of $3 50

Departures from Standard—This standard year may fail to correspond with actual operations in two directions First, while the *same number* of total hours is worked in the season, they may be *distributed differently* among the months The period of maximum pressure may be shifted to right or left, or the beginning and end of the season may be heavier or lighter than standard, but with the final result that when it is over the usual or standard working hours have been reached

Second, some of the months may correspond exactly with standard but others may not, with the result that at the end of the season a *different number of working hours* will have been reached In this last case costs for the whole season will obviously be more divergent from standard than in the first case

1 *Standard and Actual Hours Agree*—In this case there should be no divergence between standard cost and actual charges If, however, there are several production centers or delivery points and one or more of them run shorter hours than they should, then there will be waste of manufacturing capacity of the usual kind, which is chargeable to profit and loss

2 *Actual Working Hours Less than Standard*—In this case all the annual charges assigned to the month will not be taken up and charged to cost through process rates, even though hourly charges may have been reduced pro rata with working hours In any case there will be a balance in burden account representing superfluous service, consisting mainly, if not wholly, of annual charges

3 *Actual Working Hours More than Standard*—In this case the annual charges assigned to the month will, of course, be thinned out over more hours As a result, actual hours at standard process rate will distribute to cost more annual charges than are present in the month's allowance This gives a credit balance to profit and loss, as we have made an economy in annual charges

Result of Season as a Whole—In this class of industry seasonal activities are difficult to control or to forecast, as regards the distribution of pressure in particular months Moreover, the important question is that of the final result of the season's operations It has already been pointed out that normal manufacturing capacity has in these cases little to do with the actual capacity of *machinery*, because a wholly different fundamental condition exists to that in ordinary manufacturing

It is rather normal *output* that must be kept in view, and this on the basis of comparison of one year with another In other words, such plants may be considered as having a normal annual output, from which, if taken as standard, increases or decreases may be measured, and this normal output takes the place of the normal manufacturing *capacity* of ordinary plants

In entering on a new season, what should be kept in view? Obviously, the first question will be How are costs coming out as compared with standard? Assuming that service factors have been correctly scheduled and that material is passing delivery points at the normal speed of processing, then any discrepancy between actual charges and standard cost will be due to difference (if any) between standard hours, as assigned to the month, and actual working hours

In ordinary manufacturing the economies or losses thus brought out would not be considered as affecting true cost, because that is based on maximum capacity conditions But in the present case the operations of the season must be considered as a whole, consequently, until the season closes, the actual relations between standard and actual cost cannot be known For this reason the discrepancies each month, if any, are not chargeable to profit and loss, but a new device must be made use of to enable us to observe this relation from month to month, cumulatively or progressively

Progressive or Cumulative Supplementary Rate —The operations of a seasonal industry partake to the nature of a *single prolonged operation* in a sense that ordinary manufacturing does not We are not so much interested in what has happened in any particular month, therefore, as in what has happened to date, *i e*, since the beginning of the season While the standard hours allotted to each month indicate what may be expected, on the other hand, various causes may check or increase actual productive hours as compared with standard Consequently, an ordinary supplementary rate, which marks variation from standard, might be plus or minus in any given month Although this information is of value, it would be more convenient if the supplementary rate represented deviation from standard from the beginning of the whole series of operations to the present moment

Let it be assumed that standard working hours were fixed as Fig 38 and service factor charges as Fig 39 Now, let it be

further assumed that the actual working hours in the season came out as below, owing to crop conditions or other controlling circumstances that could not be foreseen

Month	4	5	6	7	8	9	Total
Working hours	150	250	400	400	350	250	1,800

In this case it will be seen that the crop was late, giving rise to lighter production in the first two months and heavier production in the two last, but leaving the total working hours in the year unaltered

With the same expenditure as in Fig 39, it is obvious that the cost of the production, taking *the whole season* into account, would be the same as before, that is, a process rate of $3 50 would have distributed all of it without remainder

But at the beginning of the season this final agreement between standard and actual working hours could not have been foretold Consequently, it becomes desirable to set up some mechanism by which cost at standard is compared with total cost But to do this for each month *separately* would give little assistance What is wanted is standard cost of all output *to date* compared with total cost of operation *to date* In other words, the figures must be *cumulative* from the beginning of the season, each month's results being added, month by month, to those of the preceding months

First Month —Figure 40 shows the results for this month As the standard process rate is $3 50 and 150 hr have been worked instead of standard 200, the charge into cost is only $525 instead of $700 (as in Fig 39) Actual charge to burden account will, however, be less than $700, because, although annual charges are the same ($400), the hourly charges will be less, namely, $225 instead of 300 The final result is that after costing output at standard rate, a balance of $100 is left This is about 19 per cent *additional* on standard cost Figure 41 shows how this affects the cost of a single case

Supplementary Cost Only a Memorandum —This supplementary rate of 19 per cent is applied to true cost by way of a memorandum, not as official cost, which remains at standard It serves merely to point out that expenditure, *at the end of the first month's operations*, is 20 per cent ahead of standard cost

The actual balance of $100 is carried forward to the next month and consolidated with the results of *that* month, thus giving a new *result to date*

Standard hr 200 Actual hr 150		To end of first month
Charged to production 150 hr @ $3 50		$525
Burden account charges		
Annual charges per schedule	$400	
Hourly charges 150 hr @ $1 50	225	
Balance, undistributed (19%)		100
	$625	$625

FIG 40 —Cost of production to end of first month

Cost of case of goods taking 3 hr to process	
Standard process cost	
3 hr @ $3 50	$10 50
Supplementary cost	
19% on standard	1 99
Total	$12 49

FIG 41 —Cost of case end of first month

Second Month —Figure 42 shows the results of the working to the end of the second month, 250 hr @ $3 50 were charged into cost, and a balance of $200 now stands undistributed This, of course, includes what was undistributed at the end of the first month What does this $200 represent?

It represents what is still undistributed after all expenditure to date since the beginning of the season has been assembled and set against all production at standard cost since the beginning of the season That is to say, after having charged all of the product at standard cost, we have, at the end of the second month, a portion of our actual expenditure not charged to cost The question then arises What percentage of total production does this now represent? Total production is

First month, 150 hr @ $3 50	$ 525
Second month, 250 hr @ $3 50	$ 875
Total production at standard to date	$1,400

The $200 undistributed at the end of the second month is about 14 25 per cent of this $1,400

The cost of a case of goods which takes 3 hr to process is then shown by Fig 43 Applying the new supplementary rate (14 25 per cent) to the standard cost of the case, we have a new inclusive cost of $12 or about 49 cts *less* than the price calculated for the previous month In other words, our actual cost is *approximating toward* standard cost

Standard hr 300 Actual hr 250		To end of second month
Charged to production, 250 hr @ $3 50		$ 875
Burden account charges (hr, month)		
Brought forward	$ 100	
Annual charges per schedule	600	
Hourly charges, 250 hr @ $1 50	375	
Balance, undistributed (14¼%)		200
	$1 075	$1 075

Fig 42 Cost of production to end of second month

Cost of case of goods taking 3 hr to process	
Standard process cost	
3 hr @ $3 50	$10 50
Supplementary cost	
14¼% on standard	1 50
Total	$12 00

Fig 43—Cost of case end of second month

Why Supplementary Costs Are Only Memoranda – The reason why the so-called "inclusive cost" found by adding supplementary cost to standard is only a memorandum or indicator and not an official part of cost will be understood from what has been shown to have happened above The same case (we may assume it to be the same case) has only one standard cost, namely, $10 50, in each month but two inclusive costs, namely, $12 49 and $12 The first of these is the inclusive cost taking into consideration only the first month's working The second is the inclusive cost taking into consideration *two* months' working In this instance the figures may be considered as encouraging,

inasmuch as the tendency is to approach standard cost The supplementary cost is, in fact, merely a guide to what is happening from month to month For a single month it has no phenomenal value, but as an indicator of the cumulative trend of the operations it has great value and interest

Remaining Months —The table (Fig 44) will be sufficient to demonstrate the behavior of the rate from month to month until the end of the season The third and fourth months were normal, that is, they conformed to standard in all respects No more undistributed burden was added to that already piled up But as the output at standard cost was at a maximum during each of these months, the $200 undistributed when placed over against cumulative production necessarily gave rise to a smaller percentage, namely, 7 and then 4¾

Month	Std hours	Actual hours	Actual expend	Standard cost	Balance	Cumu %
1	200	150	$ 625	$ 525	100	19
2	500	400	1,600	1,400	200	14¼
3	900	800	3,000	2 800	200	7
4	1 300	1,200	4,400	4,200	200	4¾
5	1,600	1,550	5,525	5,425	100	1 8
6	1,800	1,800	6,300	6,300	None	None

Fig 44 —Cumulative results one to six months

In the last two months actual working hours were above standard, consequently, a saving on annual charges would be made, and this begins to wipe out the undistributed balance which, at the end of the fifth month, has fallen to a mere 1 8 per cent of the standard cost At the end of the sixth and final month, all of the balance is wiped out, and standard cost and actual expenditure tally completely, because standard and actual hours for *the whole season* agree

Reading the Monthly Results —This approximation of standard process cost to inclusive cost is not the only matter which would require scrutiny from month to month In order to exhibit this feature clear of all others, it has been assumed that it contained the only variable quantity In practice this would not, of course, be the case Other variables exist and must be kept in view

1 *Rate of Processing* —While $3 50 per hour is the standard process rate, the quantity of material processed in the hour is, of course, one of the most important variables of cost It was assumed above that 3 hr was the actual processing time for a case of goods But this is naturally a matter of record The number of cases, cans, or other measure of goods ready for market produced *per hour* is an important variable in cost

2 *Standard and Actual Service Factors* —It was also assumed above that actual expenditure in any month corresponded to standard service factors in proportion to hours worked This might not be absolutely the case Variation is, however, unimportant unless comparison of the two shows that new and *unforeseen* items have come into the actual expenditure and are not represented in the factors In this case the factors should be revised, a very small operation in this class of industry

3 *Direct Labor* —The process rate in this type of plant might very well include direct labor That is to say, an additional service factor may be set up which assembles all direct labor just as any other class of expenditure is assembled Each production center (if more than one) is then charged with an hourly sum equal to the normal wages of the operator employed at such center By this means the separate accounting of direct wages is obviated, and where unskilled labor at about the same rate of wages is employed on the same class of work, it is the better plan Where, however, piecework is used it cannot be employed

4 *General View* —In the progress of operations from the beginning of the season toward the end, it should be the aim to get a general impression or sense of what is going on, as well as definite costs per unit of goods produced As remarked above, the true unit of this class of production is the season, and the most interesting query will naturally be, at all times How is the season coming out? And this implies How is it coming out in reference to some ideal we have in mind? In other words How is it coming out in reference to standard service factors and standard process rates? The actual speed of production, *i e*, rate of passage of materials past delivery points, is also very important, but is a much more manageable matter and less liable to get out of hand than any of the other variables

By scheduling each factor separately, any observed increase is quickly located and its significance ascertained Is it legiti-

mate or not? Is it permanent or not? These queries can be very quickly answered when the purpose of every item of expenditure has been scrutinized in advance.

Assuming that scheduled factors and actual expenditure agree, we may infer that the season is going on all right in that respect. The next question will be whether standard process rates are transferring all factor service as actually expended into cost. If the actual working hours for a month are different from those assigned as standard, this will not be true. By applying the supplementary rate we are enabled to measure the amount of this discrepancy and observe its relation to standard cost, *as far as the season has yet advanced.* If it shows a diminishing ratio (as in examples above), then it may be inferred that the season is progressing satisfactorily in this respect also.

The question of how much product is passing delivery points per hour has, of course, nothing to do with the season. It has no seasonal aspects at all. For this reason it need not be further considered. It is a variable wholly independent of other variables, and its alteration, if alteration is needed, is a matter of technical investigation.

Second Variety of Seasonal Industry.—We have now to consider the type of industry in which, while the main product is seasonal, the equipment is of such nature that it can be utilized in the off season, at least to some extent. Or again, while the original equipment cannot be so used, other equipment is brought into operation, served by the same service organization and operated by the same operators. Thus, for example, a concern manufacturing ink, which cannot be transported in cold weather, may take up the manufacture of pens, thus occupying their organization and operative force, although using, of course, quite different productive machinery in the two cases.

Under these conditions we have virtually two separate businesses, not operating simultaneously but in sequence. When one finishes the other commences its activities, and *vice versa.* The simplest method of dealing with such a condition is to treat each class of production separately. Service-factor schedules will be divided into two halves, each dealing with one portion of the year, and, from these, process rates will be applied separately to the two kinds of production, it being then a matter of indifference whether the same or different productive equipment is used for each kind.

While the principal production will be arranged on the lines suggested in this chapter, it is probable that the secondary production (in the off season) will be of an ordinary character That is, it will be based on a steady output of, say, 50 hr per week This being the case, ordinary factors and process rates will be set up, and the usual routine of costing followed

CHAPTER XVI

INTERMITTENT EXPENDITURES

The greater part of the items entering service factors are derived either from annual sums which have to be divided over standard hours, or from hourly sums which are proportional to working hours Outside of these there exists, however, a third class, which may be termed "intermittent" expenditures, inasmuch as they are derived neither from natural hourly amounts nor from natural annual amounts On the contrary, such expenditures occur at different times, are in varying amounts and have no close actual relation to the necessities of production The cost of lighting and of heating, which varies according to the season, temperature and weather, and the cost of all kinds of repairs, which may be carried out continuously or spasmodically, or may even be shut off altogether for a term, can be taken as illustrative of intermittent expenditures

Relation to Factor Cost —The general solution of intermittent expenditures is to reduce them to an annual amount which is then treated like any other amount In Fig 45 the upper bar

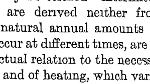


FIG 45

represents intermittent expenditures of various magnitudes scattered over 12 months The lower bar represents these same amounts reduced to even incidence on each month It is these latter amounts which are charged into factors In practice, however, the matter is not quite so simple as this and will, therefore, be considered in some detail

Expenditure on Lighting as Example —The lighting of factories is a convenient example of intermittent expenditure, inasmuch as it varies from month to month independent of production In Fig 46 the distribution of lighting service throughout 12

months is shown. The first column gives the number of light-hours per month, and the second, the budgeted cost of such lighting.

The cost of lighting for the year is $1,650, and, if the standard working hours for the year are set at 2,400, this gives a lighting factor rate (if a separate lighting factor is set up) of $0.687 per hour.

We have now to observe what happens when production is charged each month at $0.687 per hour uniformly through the year, it being assumed that each month has 200 working hours.

Month	1	2	3	4	5	6	7	8	9	10	11	12	Total
Hours	50 $250	50 $250	40 $200	30 $150	20 $100				20 $100	30 $150	40 $200	50 $250	330 $1,650

FIG. 46.—Lighting distribution.

In the first four and last three months, actual bills for lighting will exceed credits through process rates, thus:

The combined total of these balances is $487.50, which represents an excess of charges for lighting, during these particular months, over the amounts charged into cost through process rates.

In the middle months (five to nine inclusive) credits through process rates will exceed bills for lighting, thus:

The combined value of these last balances is $487.50, which represents an excess of charges to production through process rates on account of lighting over actual expenditure as per bills.

It will be observed that these two sets of balances exactly cancel each other, so that, at the end of the year, all bills for lighting will be represented by charges to production through service factors and process rates, assuming that working hours have been utilized to the full.

An intermittent or seasonal expense, therefore, which in this instance is of the hourly class, can be so included in process rates as to distribute itself to jobs evenly throughout the year.

Departures from Normal Working Hours.—It would be practically impossible to argue that the lighting factor described in the last paragraph is not fairly and accurately charged to production under the conditions given. As long as normal conditions hold, the year's production is evidently being charged with its actual share of lighting facilities.

It is now necessary to consider what happens if the normal or standard working hours are departed from The most extreme case of this would be if a contract involving heavy overtime in the winter months were being considered In this case, as explained in Chap XIII, it is evident that we are deliberately entering on a period in which conditions, as standardized, no longer exist New process rates to meet these conditions will obviously be required But departures from standard working hours may be temporary and accidental, or at any rate not foreseeable The behavior of expenditure, factors and process rates under these circumstances will now be considered

In the examples given above it was assumed that lighting was obtained from public mains and that billing was in strict proportion to supply consumed For this reason there is no charge whatever in months 6, 7, and 8, although in practice, even if current were taken from mains, some small charge for interest, depreciation and maintenance of interior wiring and lamps would be applicable all through the year, as an annual charge It will be seen later that the above assumption is the most unfavorable that could be made, inasmuch as if power were generated in the firm's own plant, reduced service in winter months would not mean proportional reduced charges as is assumed here

It will be evident that shorter working hours in the summer months will have a different effect than in winter The charges into cost will, of course, be absolutely the same, namely, at standard process rates, but the effect as to balances will necessarily be different It is the significance of these differences and how we are to regard the balances that must be analyzed

1 *Short Time in a Summer Month*—In month 7 (Fig 47) there was no billing for current, but there was a charge into

Month	5	6	7	8	9
Actual bills	$100				$100
Charged in process rates	137 50	$137 50	$137 50	$137 50	137 50
Balance	$ 37 50	$137 50	$137 50	$137 50	$ 37 50

FIG 47 —Months in which lighting charge is overdistributed

cost and, therefore, a credit to burden account of $137 50 was made Now it will be assumed that only 150 hr were worked

in this month, and that, consequently, the amount in question became $103 05 Here we have a reduced credit to the extent of $34 45 What is the precise significance of this $34 45?

Considering the year as a whole, an unforeseen happening has led to fewer working hours than anticipated Certain services will, therefore, be provided in amounts some of which will be superfluous Of the total annual lighting charge for the year, $34 45 has become superfluous, because there is no production corresponding to it Hence, this amount cannot be charged into cost If production had been normal in this month, $137 50 would have been so charged, but, as it is, of the total amount allotted to the month by lighting factor, only $103 05 can be so charged Burden account is charged with $137 50 for the month, and only $103 05 is credited to burden The balance, representing superfluous service, is, therefore, legitimately charged to profit and loss

2 *Short Time in a Winter Month*—In the twelfth month the position is quite different A bill for lighting amounting to $250 was charged into burden, and, if full time were worked in this month, a credit of $137 50 would have been made This would leave a balance of $112 50 (Fig 48) which, if full time had been worked in all the previous months, would exactly cancel previous balances, so that all lighting charges would have been charged into cost

Month	1	2	3	4	10	11	12
Actual bills	$250	$250	$200	$150	$150	$200	$250
Charged in process rates	137 50	137 50	137 50	137 50	137 50	137 50	137 50
Balance	$112 50	$112 50	$ 62 50	$ 12 50	$ 12 50	$ 62 50	$112 50

FIG 48—Months in which lighting charge is underdistributed

But if we assume that only 150 hr were worked in this month, and that the 50 hr thus lost were precisely those calling for artificial lighting, then there would be no charge for lighting to be debited to burden account, but a credit of $103 05 for the 150 hr actually worked This would imply that a certain amount has been charged into cost for which there was no actual expenditure How must we regard this condition of affairs?

Regarding the year's production as a whole, it appears that, owing to unforeseen circumstances (curtailment in the twelfth month), we have made an *unexpected economy* in lighting service Obviously this economy in the twelfth month cannot be expected to affect the cost of what has been produced in months 1 to 11 Nor does it seem logical to consider that the jobs which were done in the twelfth month, under conditions which rendered it unnecessary to use artificial lighting, should be considered to have been processed cheaper than those of other months Much the more logical conclusion is that all jobs throughout the year have been done at standard cost and that this unexpected economy in the twelfth month should be allowed to go to the credit of profit and loss

3 *Peculiar Character of Lighting Charge*—Lighting factor charges were selected for discussion because they afford an example of quite peculiar character and difficulty In a sense, lighting is both an annual and an hourly charge Actual expenditure is confined to certain months, in proportion to hours of darkness, but it is obviously necessary to spread the charge over all production for the year There will thus be credits from every month but actual expenditure only in the winter months Other annual charges, such as salaries, depreciation, etc , bear evenly on all months (provided they contain the same number of hours), charges and credits being equal at full time in every month But in the case of lighting, short time in winter months cuts the charges but not all the credits, and this affects the whole year to some extent, since *the final effect is that the total annual expenditure is different*

In practice, however, the problem is fairly simple The saving owing to curtailed production in the winter months would simply be offset against losses on other factors The net result would be that inefficiency due to curtailment would come out *less* than if no such economy had been made Standard costs would be unaffected, as they are based on maximum capacity conditions, but the charge to profit and loss would be less than it otherwise would be

Curtailed production in the summer months has the effect that part of the lighting charges are not charged into cost This is simply an ordinary case of superfluous service and does not require any further discussion The unused or excess portion of the service is charged to profit and loss, as usual

The maxim that unforeseeable and accidental losses or savings are not a part of legitimate cost justifies the relations here observed between actual expenditure, factors and process cost

Expenditure on Repairs —Repairs also form a peculiar class of item, inasmuch as the annual charges represented in the factors may be expended very irregularly throughout the year, and, moreover, have no necessary relation to the hours of production actually worked in any shorter period, such as a week or month That is to say, that though production may be curtailed even to the closing down point in a particular month, it does not follow that the expenditure on repairs will be cut down at all Further, though repairs may be scheduled to take place between certain dates, or during certain periods, they may be actually carried out at other times as convenience dictates

1 *Annual Expenditure and Monthly Factor Charge* —Assuming months of equal hours, say 200, then the repair item in any factor will be the annual total of such item divided equally between the months In Fig 49, an annual repairs charge of $600 is shown divided into monthly amounts of $50, while the actual expenditure on the repair work is considered to be made at the rate of $100 per month in the fourth to the ninth month

Month	1	2	3	4	5	6	7	8	9	10	11	12
Factor charge for repairs	$50	$50	$50	$ 50	$ 50	$ 50	$ 50	$ 50	$ 50	$50	$50	$50
Actual expenditure				100	100	100	100	100	100			

FIG 49 —Scheduled and actual expenditure on repairs

In the event of the plant working full time throughout the year, it is evident that all the cost of repairs will be charged into cost through process rates at standard

2 *Shifting Time of Repair* —If, instead of being carried out between the fourth and ninth months as forecasted, they are done in the second to eighth, or fifth to tenth, or even broken up so that they are only carried out on alternate months, no effect is produced on the *ultimate* relation of factor charges and actual expenditure In any of these cases, the result will be that, at the end of the year, $600 will have been expended and $600 charged into cost by standard process rates

3. *Effect of Curtailed Production.*—If, however, it should happen in the fifth and sixth months that production was curtailed to the extent of 25 per cent, but repairs were carried out as usual, this would result in charges into cost, through process rates, being only $575 in the year, while repairs remained at $600. This implies that $25 ($12.50 for each of the two months) remains as a balance, there having been no production to absorb it. We have, therefore, to charge $25 to profit and loss.

It may be asked why this $25 is not a part of legitimate cost, just as it would have been had we foreseen the curtailment beforehand and had thus based our factor charge on 2,300 instead of 2,400 hr. This query may be answered by a counter-question. If it is proper to increase standard cost by this amount, what particular jobs among those done during the year should be selected for this increase?

It would be very difficult to assert that any one job should suffer increase of cost on this account. Obviously, the fact that in the fifth and sixth months production was curtailed without a corresponding curtailment of repairs is a purely accidental condition. Exactly the same final result would occur if the repairs *had* been curtailed in those short months and carried out in later months. However, the repairs were distributed and wherever the shortage of working hours had taken place, at the end of the year we should have the same story, namely, the $600 expended for repair would be set against a shorter number of working hours than was included in the standard factors.

4. *Under Hourly Burden Method.*—If an hourly burden method were being used in these circumstances, costs would be increased just where the shortage of working hours overtook the expenditure on repairs. That is, they might be increased in the fifth and sixth months, or, if repairs were postponed, then in any later month. This, of course, means nothing. The selection of certain jobs for increased cost has no justification, since the selection of the particular jobs will shift from month to month until the arithmetical discrepancy is satisfied. No facts of production are expressed by this performance.

5. *Facts of Production.*—On the other hand, it is evident that, considering the whole year, there has been a failure to utilize maximum manufacturing capacity. Consequently, as all manufacturing capacity has to bear part of the cost of repairs, among

other things, it is evident that the portion which was attached to the hours wasted is now set afloat, as it were, and cannot be considered as part of the cost of any job In other words, it must be a charge against profit and loss Standard cost thus remains unaffected The true facts of production are thus represented

Repairs of an Extensive Character —It may be explained here that such repairs as are charged into cost through factors and rates are the ordinary yearly repairs For example, if it should happen that very extensive repair and overhaul of buildings were undertaken in any year, and that such expenditure was in the nature of renovation and, therefore, greatly exceeded ordinary repairs, then such unusual expenditure should be held in a suspense account and distributed over the next few years in reasonable amounts This aspect of the matter will be dealt with more fully in a later chapter The point to be noticed here is that the factors which determined cost should be kept as near normal as possible The cost of accidents and catastrophes should not be permitted to enter, for to do so would increase costs unduly, and *no corresponding increase of sale price can be made* The customer cannot be made to pay for them An extensive renovation implies the concentration of expenditure in 12 months which would otherwise be spread over several years The cost of such renovation should, therefore, be permitted to enter factors only in such a way that the future years which benefit are charged with their just share, instead of charging the whole amount in the year the expenditure happened to take place

The same argument applies in other ways Departures from normal should not affect standard cost If part of the working year is lost, the cost of the manufacturing capacity so lost (including, as above, the item of repairs) should be charged to profit and loss No higher price can be obtained because we have lost part of our capacity to produce, and it is, therefore, absurd to increase cost on that account

Conclusions —When expenditures on any item entering into a service factor are intermittent in character, the final result will depend on the relation of its annual total to the annual total of working hours If both of these quantities correspond with the amounts scheduled in the factors, then the actual distribution of the expenditure in different months does not affect the final result

Jobs will have been charged at standard cost, and at the year-end no surplus or deficit of the item will be left to be dealt with in any other way

At the end of the year, however, if working hours have varied from standard, or actual expenditure has been more or less than that scheduled in the factors, a balance will be left over This balance may represent an economy or a loss, according to the actual circumstances, and is ordinarily carried to profit and loss

In the case of repairs, having in view that the life of the building or equipment benefited extends over many years, it might be considered advisable to carry forward any balance so left to the next year This is, however, a matter of judgment In general the amounts so to be dealt with will be small and no substantial injustice is done by clearing them up in the current year by charging or crediting profit and loss with the amounts in question

Exceptionally heavy repairs, amounting to renovations, should not be charged at once in the current year, but should be divided over two or more years and the amounts chargeable to succeeding years held in a suspense account

CHAPTER XVII

LEGITIMATE OVERHEAD

Items of manufacturing expenditure, *i.e.*, overhead items, can be charged out in one of four ways: (1) to sales expense, thus passing out of the sphere of this book; (2) through burden, *i.e.*, through factors and process rates, into cost of jobs; (3) direct to the job without passing through a factor; (4) not to any job but direct to profit and loss account.

Methods 1 and 2 are, of course, routine practice. Method 3 is only employed when some special outside expense on a job has been incurred, such as the sending of a man to customer's plant to take measurements, etc. This case need not be further considered. There remains method 4 which is the case to be considered in this chapter. The question to be discussed is whether there are such items, and if so, why they should be charged direct to profit and loss instead of through factors, rates and costs in the usual course.

Characteristics of Normal Overhead.—When the term "normal overhead" is used it implies that the *usual, ordinary and current expenditures* of the business are in question. Although, as we have seen (Chap. XVI), some of these charges may not flow equably from hour to hour but are intermittent in their nature, considered from the viewpoint of a whole year, they are regular enough and can be charged into cost on an hourly basis. It is also a natural outcome of the characteristics of normal overhead that it is forecastable. It can be budgeted in advance with considerable precision. But this again implies that it does not include what may be termed "catastrophic" items, that is, sudden and heavy outlays of an unforeseeable nature.

The operations of manufacturing are those of a steady routine. Even though the same items of product are not concerned, the shops do, as it were, go through the same motions day by day and month by month. The more regular and automatic the operations of the shops, the closer they attain to efficiency. The more irregular the flow of product the greater the number of

breakdowns and interruptions the less the efficiency. This is a platitude, but the inference from it is of some importance. It follows that production at its maximum efficiency is a smooth, steady process, and that, consequently, normal overhead (which is the cost of maintaining the plant in a state of preparedness for production) must also be smooth and steady, and can contain only such items as contribute to the upkeep of steady production.

From these considerations it may be further inferred that normal overhead consists of *recurrent* items, that is, items which in their facilitation of a steady routine of processing occur periodically and are repeated over and over again. That this is the case is not obvious at first sight, but it will be seen that all normal overhead is so resolvable.

Recurrent Nature of Normal Overhead.—A large proportion of overhead consists of depreciation, interest, insurance, taxation and similar items. These are annual charges, but when reduced to an hourly basis may be said to be recurrent. Hour after hour they are repeated, so that each hour takes up an equal amount of them. Salaries are closely similar in effect. They may be considered as bearing equally on each of the standard working hours throughout the year. All indirect wages (service wages) are obviously recurrent in nature. Whatever service is performed, say by transport men, is performed hour after hour in recurrent fashion. The cost of repairs appears at first to make an exception to this rule, but the *necessity* for repairs is due to the gradual wearing out of buildings and equipment, which may be pictured as taking place hour by hour, even though the effects are visible only at irregular intervals. Similarly, though actual expenditure on repairs may be intermittent, it may be considered, both theoretically and practically, as being made hour by hour concurrently with the wear and tear it remedies. It was shown in previous chapters how, in practice, intermittent expenditure can be reduced to an hourly charge, and the reason is now seen. It is a maintenance of efficiency, the converse of which (wear and tear) can be regarded only as taking place steadily, hour by hour, in some close relation to actual working hours.

We may picture production, therefore, as a series of operations which are much the same in one hour as in any other. Similarly, the expenditure (overhead) which maintains the plant in a state of preparedness for this production must also be regarded as

doing its work hour by hour, much the same degree of maintenance being required in one hour as in another throughout the year. Normal overhead is then *expenditure on the ordinary routine of production*. Such overhead is obviously a legitimate charge to cost on all methods, and its subsequent division into utilized and wasted or into utilized and superfluous service has no bearing on the matter. It is the cost of *preparedness* for regular even production, and whether all the preparedness is used for production is a *subsequent* consideration that does not affect the collection of the items which constitute legitimate overhead.

Expenditure Not Legitimately Chargeable in Cost.—Having now defined legitimate overhead, it remains to consider whether there are other classes of expenditure that do not represent the cost of regular even production, and, if so, their destination and in what way they affect cost and profits.

In the first place it will be evident that items like those indicated as belonging to class 3 on the first page of this chapter are not part of legitimate overhead. If extra help has to be hired to handle an exceptionally heavy and awkward casting belonging to a customer's order, or, as in the instance cited above, someone goes on a trip in connection with the business of a particular order, the expenditure in these cases is not of a general nature. It has nothing to do with maintaining a general condition of preparedness in the plant. Obviously, then, it is an item of overhead which is chargeable not to any factor or service but to the individual order that has benefited by the expenditure.

Expenditures of class 3 come between those of classes 2 and 4. They are not a part of legitimate service overhead, neither are they chargeable to profit and loss. Their destination will be sufficiently obvious, namely, as a special charge to the order itself. But this means they form part of the cost of that order and thus ultimately diminish the profit on the order by just so much as they amount to.

Special cases of this kind having been eliminated, we are left with a clear field for the inquiry. What items of expenditure must be charged direct to profit and loss?

The nature of these items can be inferred from what has been said above. They must be exceptional, irregular or even catastrophic in their nature. They can have nothing to do with

maintaining a regular and smooth condition of preparedness for production, nor can they be chargeable to any particular order In other words, they must be of such nature that if we were to include them in cost, no further increase in selling price could be obtained on that account They are of a class of expenditure for which no customer can be expected to pay

What the Customer Pays for.—The necessity of limiting normal overhead to the ordinary, steady and recurrent items of expenditure will be understood when the relation of cost to selling price is considered

What determines selling price? Except in the case of monopolistic industries, the obtaining of business is determined by market competition If two plants are in competition, one of which charges into cost (and, therefore, into its quotations or bids for new business) only the normal and legitimate items of overhead, and the other includes exceptional and catastrophic items, it will be difficult for the latter to complete So far from paying for the illegitimate items by including them in cost, it will fail to fill its plant with work and thus neither the illegitimate items nor all of the legitimate ones will be covered Not only does the inflation of costs hamper the getting of business but also it endeavors to get out of the customer what should be paid for out of our own profits If the customer is offered goods, elsewhere, at a price based on the normal and regular expenditure on production, he will take them in preference

But if the plant is not filled with business, it will not be possible to pay for the exceptional charges at all If it were filled with business on the basis of normal expenditure, there would have been a fund of profit which would then be diminished to a net amount by paying for the exceptional charges In the absence of business, no fund of profit will be available for this purpose

In all cases the customer pays for production of a regular and normal character He will not pay for anything else This principle is generally recognized in its most decided manifestations, as, for example, if we have a fire and a portion of our plant is put out of business for a time, we do not expect to raise the selling price of our product on that account We understand that the customer will not pay for our fire We cannot add our loss into costs and base our price on the enhanced cost When we resume production the customer will go on paying the same price as he would pay to our competitor who had

no fire The cost of the fire must be met by us out of profits In other words, a catastrophe of this character obviously comes under class 4 as being no part of legitimate productive overhead but as a charge to profit and loss direct

While this principle is generally recognized in the case of a serious catastrophe like a fire, it is very often not so recognized in less catastrophic items Nor is it always clearly understood *why* such catastrophic expenditure cannot be recovered in cost, though the practical impossibility may be clearly understood

Why Catastrophes Are Not Legitimate Overhead —It would be easy enough to gather up the various expenditures incident on the occurrence of a fire and consider such total as spread over cost through overhead during, say, the coming year As it is generally recognized as practically inadvisable to do this, there must be a theoretical principle to support this practical viewpoint If legitimate overhead be defined as that which contributes to the maintenance of preparedness for production, and if, without including catastrophic item, such preparedness is fully maintainable, then its presence is obviously not required To include it would be to add something *beyond* the ordinary, necessary and current expenditures which are sufficient to maintain preparedness We should have, therefore, in our costs, not only legitimate expenditure on maintaining production but also an additional and foreign element *which is not contributing in any way* to service Its inclusion would not give any *extra* productive capacity, nor would its absence diminish such capacity in the slightest degree

Although the cost of the catastrophe has eventually to be paid for out of profits, either past or future, to deduct it from profits by increasing costs simply leads to introduction of a foreign item into such costs, thereby inflating them and making them practically valueless for their principal purpose, namely, the fixing of selling price By eliminating such items from overhead and by charging direct against profit, we can perceive exactly what we are doing and all confusion is avoided

Items Not Part of Legitimate Overhead —That catastrophic expenditures are not part of legitimate overhead has now been demonstrated, and the next consideration will be whether there are other items that do not add anything to service and should, therefore, not go into overhead but be charged directly against profits

When service factors and process rates are employed for costing, the presence of a foreign item in overhead is much more quickly and easily discovered than if all expenditure is lumped together as overhead or burden For the first question on considering any item of expenditure will be To what factor does this belong?

Unless an item of expenditure is for the purpose of rendering a service to production, that is, unless it assists in the maintenance of the plant in a condition of preparedness, it has no place in legitimate overhead

Among the items that are chargeable direct to profit and loss on this account may be mentioned the cost of a heavy breakdown In former days when slow-moving condensing engines with enormous flywheels were in use, it sometimes happened that such flywheels burst, scattering destruction far and wide The expenditure thereby incurred served not to facilitate production but merely to *restore* the condition of preparedness obtaining before the accident happened In the same way, boiler explosions, collapse of chimneys, etc , belong to the category of catastrophes, and the cost of restoring normal conditions does not form part of legitimate overhead

Unexpected and sudden expenditure of any kind, which rarely can be said to serve production from the very fact that such expenditure is spasmodic and not regular, must be treated in the same way If, for example, the plant is closed down for a day, owing to the death of the president of the concern or to an occasion of public mourning or public rejoicing, the loss thereby incurred must not be charged into cost, that is, not into legitimate overhead No service to production is implied It must be met out of profits

These are fairly obvious cases There are others, however, in which the distinction is not so obvious, inasmuch as it is possible to argue that production is benefited indirectly if not directly In this class are expenditures on what may be called "betterment work" When a plant is being placed on a modern footing by the introduction of production control, cost systems, time study, etc , the expenditure here incurred, although it is undertaken in the expectation that production will be increased or cost reduced, is obviously not a part of the regular and steady cost of production On the contrary, it is distinctly terminable in character, even though it should last for two or

more years in installation Of course, any additional expenditures of a *permanent* character which are set up by such reorganization, such as salaries of production men, cost clerks, etc, will be included in legitimate overhead, since these are recurrent and directly serve current production

Likewise, expenditure in the way of providing playgrounds, clubs, entertainments, Americanization classes, etc, should be met out of profits, though it may be argued that production is benefited in an indirect way, and the object of the expenditure is so to benefit production Still, it is perfectly obvious that such items are entirely optional and not by any means *essential* to production In other words, they do not form an integral part of the productive operations If, therefore, it is the policy of the executives to provide these auxiliary benefits, it should be done out of profits, and the cost of goods should not be increased on this account

Modernization of Equipment Obsolescence—Another kind of expenditure, and one of great interest, is that which arises from the replacing of existing machines or equipment by more modern and advanced types Ordinary wear and tear is assumed to be taken care of by depreciation, and this, of course, is a normal and ordinary item of legitimate overhead But the replacement of equipment long before it is worn out, so that, after deducting the residual value which may have been recovered by sale of the old equipment, a loss of importance results, is another matter The question is How is this loss to be dealt with?

Three ways are available The amount so lost may be (1) added to the cost of the new equipment and treated as an addition to value It will thus eventually be charged to cost through depreciation (2) It can be included in overhead and charged into cost that way, or (3) it can be written off to profit and loss, either at once or in the course of two or more years

The first method is that commonly followed in the case of real estate and the buildings erected upon it The tearing down of an old building and its replacement by a new one is, practically, an addition to the capital value of the occupied site But in this case the operation is masked by the rising value of the property due to outside causes Nothing in manufacturing has any similarity to this condition, and, therefore, method 1 is not applicable

On the second method the loss is treated as if it were a part of the cost of production. Under hourly burden or percentage systems it would be applied to burden in general, but under the service-factor and process-rate method it would be necessary to determine what factor is chargeable. We may assume that the transaction consisted in the replacement of the entire productive machinery of one department working as a single unit with one delivery point. The productive equipment factor is, therefore, the only one affected and, moreover, only as regards that one department. It would be necessary to increase this factor by the amount of the loss, and this, in turn, would lead to an increased process rate. Cost of product would be increased or diminished according as the net influence of higher process rate and shorter process time interacted (*cf.* Chap. IX). The actual influence of the amount added on account of loss might, therefore, be masked in the net result.

To isolate the effect of including loss we may suppose that the object of the new equipment was to produce a more perfect article as regards *quality*, and that *process time was unaltered* by the substitution. In this case inclusion of the loss in the factor and rate would obviously be to increase cost, since the time would be as with the old equipment, but the rate would be higher by the amount of the loss. Is this increase of cost to be considered legitimate?

The answer to this query can be sought for in relation to selling price. If we suppose that our firm were in competition with a new concern which had been equipped with the new and improved machinery, it is evident that, by including the loss of replacing our old equipment in cost, we are handicapping ourselves in competition. While the new concern would realize a normal profit on its cost when selling at a determined price, we should not be able to make a normal profit at the same price, because our costs would be inflated by the cost of the substituted machinery loss.

The third method may now be considered in reference to this particular case. If the loss incurred by replacing the equipment were charged to profit and loss, either during the current year or suspended over two or three years, then the product would compete on the market on exactly the same terms as that of the new concern. Part of the profit resulting would be set aside to pay for the replacement and the rest would be available for

dividend The fact is that the *necessity* for replacement is in the nature of a catastrophe, very similar in effect to that of a fire in which the department machinery had been wiped out In that event the new machinery would be placed on the books at its cost value and would be depreciated in the usual way and, thus, enter factors, process rates and costs, but the loss due to the fire would not be so entered That would be wiped off the slate and be met out of profits

Exceptional but Legitimate Items —It may be confessed that the dividing line between legitimate overhead and expenditure chargeable to profit and loss is sometimes rather fine and indefinite While for instance, as stated above, so-called "paternal" undertakings, clubs, playgrounds, etc , are no part of legitimate cost, other services, such as fire brigades, medical service, rest rooms, etc , may be considered as legitimate, because they have an intimate connection with the efficiency of production They are, in fact, a contribution to preparedness Moreover, they comply with the definition in that they are recurrent Nevertheless, the inclusion of such items, or any items that do not clearly and manifestly assist directly in creating a condition of preparedness for production, should be made with caution Where all competitors are on much the same footing in these respects, inclusion in overhead works no harm, but if some firms are providing such services and some not, then the effect of including these classes of expenditure in legitimate overhead must be very carefully watched as regards their influence on costs

Conclusion —All expenditure must be met out of the revenue received by the sale of goods This revenue is divisible into two parts, namely, that which replaces cost, and that which is surplus or profit With a given revenue, when cost is more profit is less, and, contrariwise, when cost is less profit is more Consequently, whether or not any given item of expenditure goes into cost or is charged into profit and loss makes no difference in the long run The net profit left after all deductions have been made will be the same whichever plan is adopted But as *cost is a very important matter from the viewpoint of price making and competition*, it is desirable that only legitimate overhead should enter into it

Legitimate overhead may be defined as the expenditure which directly and recurrently contributes to preparedness for process work It is essentially confined to expenditure which promotes

the productive process hour by hour It cannot, therefore, be considered as including any expenditure that is catastrophic in character, or which merely contributes to the restoration of impaired productive conditions Nor can expenditure which is of a temporary character, such as the cost of reorganization or betterment work, be included, though any permanent expenditure arising out of this, such as additional clerical work, is to be considered as legitimate overhead

The essence of legitimate overhead is that it is expenditure on the ordinary, regular and normal routine of production

CHAPTER XVIII

TYPES OF DEPARTMENTALIZATION

Very few plants are of such a simple character that their operations can be carried on without departmentalization. While the general idea comprised in the word is commonly well-understood, it is necessary to distinguish between the different objects attained by dividing the productive process into departments.

Definition of Departmentalization.—There are two or three aspects from which departmentalization may be regarded. First, there is the question of administrative unity. From this viewpoint a department is a division of the business sufficiently individual to require a foreman's attention. The department thus becomes the limit of one foreman's jurisdiction.

But this usually implies that as between departments there is a pronounced difference in the processes carried on in them. In this respect a department becomes the place wherein a special process or group of processes is carried on.

Still another viewpoint may be used. In this a department is a single process of importance or a group of processes which forms a *separate unit for costing purposes*.

These three definitions are not mutually exclusive. On the contrary, they may all be present at one time and, perhaps, usually are. But of course exceptions may occur. Thus, two departments for costing purposes might have only one foreman who supervises both of them. More rarely, two departments with separate foremen may form one costing unit, though, in general, such officials would be subforemen with a general foreman over them, who, however, might also have jurisdiction elsewhere.

As we are dealing here with questions of cost and not of administration or production engineering, it is evident we must concentrate our attention on the third viewpoint, namely, that,

for costing purposes[1] a department is a separate unit of the plant

Departments as Units of Costing—In general, the division of the business into departments for costing purposes will follow, of necessity, its division for administrative purposes, this latter, as has already been mentioned, being for the most part dependent on the convenient grouping of processes under foremen

Usually a department is physically separated from other departments Either it is housed in a separate building or on a separate floor, or is a definite area of a building or floor which it shares with other departments It is usually easy, therefore, to allot the proper share of space factor to each department Having thus physically isolated the department, it is a mere matter of figuring on obvious bases to allot the proper share of all other factors, and so find the total of all overhead which must be borne by the department

This procedure provides for the *collection* of space and all other factor charges pertaining to a department, but, as departments are of varied internal arrangement and may contain from one to twenty or more separate processes within their confines, it is evident that the connection of service factors (overhead) with the process cost of jobs is altogether a different matter and must have some close relation to the way in which processes are laid out But this leads us to the position that, while *departments are units for assembling overhead* (factors), processes are the units *for connecting overhead with work* This latter operation is effected by means of process rates

We may assume for the present that the service factors for a given department have been assembled and totaled, and proceed to consider the various types of department from the viewpoint of the arrangement of processes and observe the different dispositions of process rates which are thereby made necessary

Internal Arrangement of Departments—Departments may be classified by their internal arrangements according as they include one or several different processes, *i e*, "single" or "plural"

[1] The term "department" is sometimes applied to a separate branch of a large business Thus, in an engineering works, there may be an "airplane department" a "marine engine department" and a "weighbridge department" It would be better to speak of such groups as "divisions," inasmuch as each of them will generally have several "departments" in the sense as defined above

types The single-type department may again be subdivided into those with one machine or one chain of machines with a single delivery point (*single-series type*) and those wherein the productive machinery is duplicated, triplicated, etc, several ranges of identical machines being set side by side with corresponding delivery points (*single-parallel type*)

Plural-type departments may also be considered under two heads The first is that in which productive machinery is made up of two or more groups or sets of identical machines, say, five milling machines all alike and six planing machines all alike, or it might be that the machines were all of the same kind (all milling machines) but that they were grouped by sizes or capacities Each machine has its own delivery point, and all machines within a group have the same process rate (*plural-group type*)

Finally, we have another plural-type department in which every machine is different from every other, either in kind or size Each such machine has its own intake and its own delivery point and works on product quite independently of other machines As each machine makes a different call on service factors, it follows that every machine has a different process rate This is the machine-shop type of department, and, although the modern tendency toward specialization leads away from the practice of mixing all kinds and sizes of machines in the same shop, instances of this type (*plural-ultimate type*) are quite common As each production center and its delivery point is furnished with its own individual process rate, it will be evident that we have virtually extended the principle of departmentalization as far as the individual production centers When each center differs in one or several respects from its neighbours, this ultimate type of the plural department is forced on us, as there is no other way by which the true cost of individual processes can be found

Mixed Types Feeder Machines—It may happen that a number of machines working in parallel with individual delivery points are served or fed by a fewer number In an envelope plant one gumming machine may serve several folding machines The arrangement may however, be more complex than this In a certain shop making the small metal stamped parts of umbrellas the course of work was this At the back of the shop large sheets of steel were passed through rollers which cut them into smaller

strips. A further stage was effected by a set of machines that cut these strips into narrow ribbons. These ribbons were fed into power stamping machines which perforated and cut out portions while still in the strip. The strip was then cut across at certain points giving small rectangular pieces. Finally, these pieces were fed into machines which bent them into the finished shape desired.

Each set of machines was not equal in number. At the back was one machine doing the first slitting of the large sheets. At the front was a long range of small machines doing the bending process. Intermediate machines increased in number toward the delivery point of the process.

Such a shop does not fall very obviously into any of the definitions yet made. But some idea of the way to deal with it from the costing viewpoint may be gathered from the consideration that the labor involved is almost entirely that of transporting material from one kind of machine to the next in series. If we suppose this to be effected by mechanical methods, then the whole shop would be one large automatic machine, consuming steel sheets and delivering finished stampings at several delivery points.

In other words, it would form a single-parallel type of department notwithstanding that the *number* of machines in successive stages was not identical. But the *output* of each stage is identical, giving a continuous and steady flow of product ending in a number of parallel delivery points, each exactly alike.

Steps or Stages in Production.—The more closely a department represents a definite step or stage in production and that alone, the simpler is the costing of the process, because there is only one delivery point to consider and, therefore, no detailed allotment of service factors to a number of individual production centers is required. The next simplest condition is where the single-parallel type is found, that is, where the single process is simply duplicated or multiplied, being otherwise precisely similar. The working hours of all such duplicate processes being thrown together, the effect is the same as though only one delivery point had been at work for a longer period. Thus, if we have three parallel processes working 200 hr. in the month at a total service factor cost of $6,000, this is equivalent to a process rate of $10 per hour, which is the same thing as regarding one such process as working 600 hr. in the month. It is, however, essential that each parallel process shall be exactly identical in all respects,

otherwise we should have three *dissimilar* machines, which would transfer the classification of the department to that of the plural-ultimate type, requiring individual process rates for each process

1 *Processes with More than One Step* —On the other hand, the changes wrought on material within one department may constitute more than one actual step An automatic lathe, for example, may carry on several changes in series on a piece without removal from the machine Continuous machinery of many kinds is commonly found wherein the raw material entering at one end undergoes several distinct steps of manufacture before it emerges from the delivery point But in these instances *the intermediate stages may usually be ignored for costing purposes* The change that is costed will be that which extends between the first form and the last

Whenever the *whole output* of a machine passes to another machine, it usually forms part of a connected process which may be costed as a single process, even though such process actually includes two steps For cost purposes the two machines are one, and the cost represents the stages between the intake of the first and delivery of the second

In the case of the stamping shop above cited, though not a continuous machine, the flow of material is so continuous and so homogeneous that only the first and last stage need be recognized for costing purposes Such a department consumes steel sheets and delivers bent and perforated single parts If, then, we know how many hours the delivery points have worked and the entire cost of all service factors consumed by the shop, an hourly department process rate is easily calculated

This process rate will be the hourly cost of the process between the stage of steel sheets and that of finished parts

2 *Non-continuous Processes* —If a department consists of several production centers each of which works independently, then it will generally be the case that each such center performs a separate and distinct step or stage of manufacture Under these conditions no departmental process rate can apply, because we are now dealing with a variety of starting and finishing stages The only thing to do in such a case is to extend the departmentalization to the individual center by providing it with a process rate of its own Then each step or stage of manufacture can be costed on its own merits, quite independently of what is going on elsewhere in the department

It will be noticed that, by thus providing each center with its own process rate, we reduce the complex department to a number of simple departments and bring it within the above definition, namely, that a departmental cost is the cost of one definite stage in the progress from raw material to finished goods

Diagram of Departmental Types —Figure 50 shows in graphic form the different types of department above described, namely

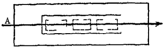
A, single-series type
B, single-parallel type
C, single-feeder-parallel type
D, plural-group type
E, plural-ultimate type

An additional diagram shows the virtual departmentalization effected by individual production center process rates These different types will now be considered in some detail

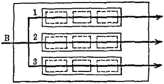
Single-series Type —In this type of department (A in the diagram) there is only one delivery point The work may, however, pass through more than one step or stage before reaching this point In Fig 50A the rectangle representing the process has three dotted rectangles inside These latter represent possible separate steps constituting the process Provided that each of the machines represented by the dotted outlines delivers the whole of its output into the next in series, so that a uniform movement of product from the intake of the process to its delivery point is produced, then such steps may be ignored for costing purposes and the process costed as a whole

All service factors for the department having been assembled, they are divided by the standard working hours of the department, thus giving an hourly process rate for the whole process, namely, all the changes which have been wrought between the department intake and its delivery point

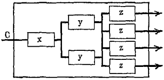
In handling product, one of two conditions may exist First, when the process is *invariable in speed,* all product being passed through at precisely the same rate Second, when the process *varies in speed* according to the nature of the material that is being passed through or by reason of varying degrees of skill in the labor operating it When the process is invariable in speed, it is not requisite to record the time of individual lots or batches of product, since such time will always be proportional to the quantity or weight in the lot But when the process speed is variable,



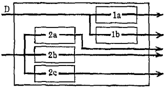
A. SINGLE PROCESS DEPARTMENT (SINGLE SERIES TYPE)
The department contains only one process with one delivery point. The process may include more than one step in manufacture, i e it may be made up of a chain of machines as represented by dotted lines Speed of processing may be constant or variable on certain work but the speed of each machine in chain must be alike A department process rate which generally may include direct labor if any covers all costing



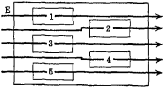
B SINGLE PROCESS DEPARTMENT (PARALLEL TYPE)
This is precisely similar to A except that there are two or more exactly similar processes or chains of processes side by side The departmental process rate is divisible by the number of parallel processes giving a rate for each separate process Speed of processing may then vary as between lots or jobs and each series may vary in speed independently of the others Each process has a delivery point



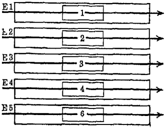
C SINGLE PROCESS DEPARTMENT (FEEDER PARALLEL)
The department contains only one process but with several connected steps Output of machine x is delivered to machines y y and the output of y y is delivered to machines z z z z. The only delivery points are those of the latter The flow of work could equally well be in the opposite direction namely intake at z z z z and delivery point at x If there is no variation in speed of processing a single departmental process rate covers all requirements of costing



D PLURAL PROCESS DEPARTMENT (GROUP TYPE)
The department contains more than one process each such process being entirely independent of the others and having its own intake and delivery point. In the group type there are more separate machines than separate processes i e some machines are alike and these form groups In the figure one group of two machines (1a and 1b) is shown and one group of three (2a 2b 2c) Each group has its own process rate divided by as many separate machines as there are in the group Speed of processing of any machine may vary as between one job and another



E. PLURAL PROCESS DEPARTMENT (ULTIMATE TYPE)
In this type of department every machine is different from every other i e none form groups Every machine has its own individual process rate Speed of processing as between jobs can vary on any machine without reference to any other There are as many delivery points and intakes as there are machines This is the machine shop type of costing wherein milling drilling planing turning boring etc machines of all sizes and capacities may be found in the same shop



E 1 E 2 ETC COMPARISON OF TYPE E WITH TYPE A
The effect of providing each production center with its own individual process rate is virtually to constitute as many separate departments of type A as there are machines In the figure the machines 1 2 3 4 and 5 of the E type may be regarded theoretically as being arranged as E 1 E 2 etc which as will be seen on comparison is precisely the same type of arrangement as in Figure A above

FIG 50 —Diagram of departmental types

then a record of time taken on individual lots is necessary. Such time multiplied by the hourly process rate will, of course, be the process cost of that lot or batch.

In some cases direct labor may be included in the process rate in this type of department. This, however, will be discussed at length in a future chapter.

The single-series type of department affords the simplest kind of costing. We have only to assemble the departmental service factors (overhead) and divide by the standard working hours of the department to find a departmental process rate. Preventable idleness of machines means wasted capacity, as explained in former chapters. While running on work, each process dollar is connected with a given amount or quantity of work, and this may, as remarked above, include direct labor. The cost of output for a month will be (Fig. 51):

Service factors (overhead) total	$2,600
Standard working hours	200
Hourly departmental process cost	$ 13
Actual working hours 190 @ $13 = $2,470, cost of actual output	
Preventable idle hours 20 @ $13 = $130, cost of wasted capacity	

FIG. 51.—Cost of output.

If 247,000 yards or pounds of product were processed (at invariable speed) in the month, then $2,470 divided by this figure gives a process cost of 1 ct. per yard or pound.

Single-parallel Type.—This type of department (B in the diagram) is in all respects similar to the single-series type A except that there are two or more precisely similar sets of productive equipment, with their own delivery points, thus duplicating or multiplying the output.

The only points needing discussion will be the effect of this duplication on the costing method. Up to the point of finding the departmental hourly process rate there is no difference, except that instead of dividing the total of service factors by, say, 200 hr., it must be divided by 400 (for two sets or ranges) 600 for three sets, and so on. As each range of equipment has its own delivery point, it is evident that the total standard working hours which will be reached by all of them together must be the divisor. Practically the same result will be attained by finding a departmental process rate as for *one* range and then

dividing it by two, three, or whatever is the number of parallel ranges (Fig 52)

Service factors (overhead) total		$6,000
Standard hours (200 × 3)		600
Hourly process cost for one delivery point		10
Actual working hours 570 @ $10 =	$5,700	
Preventable idle hours 30 @ $10 =	$ 300	

FIG 52—Cost of output

The final effect is that each range has a process rate, and, of course, these two, three, etc , rates will all be exactly alike They may or may not include direct labor

As each range is independent of the others, one range might be used for variable processes and others for a main product which was processed at invariable speed In this case the time of individual lots or batches would need recording only at one delivery point Preventable idleness would be recorded for all machines, preferably by an automatic recording device

At the month-end, if there were three machines parallel (as Fig 50B), then results would be If 741,000 yards or pounds were processed (all at invariable speed) in the month, this amount divided into $5,700 would give 0 77 cts per yard or pound

If some work were done at different speed, the results would be in this form (Fig 53)

	Pounds	Hours	Cost	Rate, cents
Order 34267	50,000	35	$ 350	0 70
" 34275	180,000	135	1,350	0 75
" 34296	17,000	20	200	1 17
	247,000	190	$1,900	
Normal speed	494,000	380	3,800	0 77
Total	741,000	570	$5,700	

FIG 53—Cost of output

The first two orders done at special speeds were below normal cost and the other considerably above it

To enable a department to rank as an example of the single-parallel type (with its simple cost method) each of the parallel

processes must be precisely similar in all respects, and any one range must be indiscriminately usable for any portion of product The speed of processing may vary, because that does not affect the process rate itself but only its transfer to product If any difference exists between the ranges or machines, then *the uniformity of conditions which is presupposed would not be present,* and instead of two, three, etc , machines or ranges of machines, all similar and having the same process rate, we should actually have a department of type E in which every machine (production center) is different, thus necessitating an individual process rate for each

Single-feeder-parallel Type —One variety of this type of department is represented on the diagram at C The general plan is that of the stamping shop above described, but with fewer steps From a cost viewpoint the problem is treated as though each of the machines with delivery points (four in the diagram) had its own chain of machines behind it The fact that these anterior machines are shared between the delivery points will not affect the costs, provided that the flow of product is uniform throughout This is equivalent to regarding the first machine x as having a capacity equal to supplying the four delivery points, and each machine y as having a capacity equal to supplying two such points In other words, though x is physically only one machine, it may be regarded as equivalent, from the viewpoint of output, to four smaller machines And so with the next step y

This reduces the department, from the costing aspect, to an ordinary case of the single-parallel type B just discussed Process cost will be for the entire series of changes between the intake of x to the delivery points of z

Single-feeder Type (Reversed) —From an examination of the diagram C it will easily be seen that the flow of work can be considered as proceeding from right to left just as well as from left to right That is, the intake may be at the four machines z z z z and the delivery point after step x The same reasoning applies in this case as before The four machines z may be regarded as one machine of four times the capacity, and machines y y as of double the capacity Then the output at each step would be the same, and, from the cost viewpoint, we have what is virtually a single chain of three machines between intake and delivery point The fact that the first machine in the series is

physically divided into four and the second into two does not affect the principle

In this case the department is reduced to an ordinary case of A (single-series type) which is the type of department having only one delivery point The corresponding process cost includes all three steps, from the intake at z to the delivery at a

Variations of Feeder Type—The feeder type of department is somewhat important in view of the increasing use of automatic and semi-automatic machinery for process work It will be understood that the arrangement shown in the diagram is only one of many that may be made For example, there might be only one machine at each end of the chain of steps, and several intermediate steps, each of which was performed by several machines simultaneously In all such cases what we have to consider is whether such groups of machines are performing the work of a single machine of capacity equal to the intake and delivery If the flow of product is smooth and continuous from first to last, then, as a general thing, the intermediate steps may be ignored and the process costed either as a single-series type (with one delivery point) or, if there is more than one delivery point, as a single-parallel type

As soon as the exact type is determined, the problem of costing is a matter of applying the regular routine for the type in question

Plural-type Departments—Hitherto the types discussed have been those which are concerned with only one process, although such process may be made up of two or more steps Nevertheless, in any of the departments of the single type, there can be no variety of operation If there is more than one delivery point, each of them delivers identically processed product The only possible difference is that in some cases product may have been processed at different speeds, but the processing itself is always the same

Now we have to consider cases in which a plurality of processes exists, that is, at least two different processes are carried on in the same department, and these processes are *not in sequence* That is, they are not, as in the case of the single departments above discussed, mere steps in a continuous process On the contrary, each machine has its own intake and delivery point, and if one process is served or fed by the others, it is on a wholly independent basis If one piece or lot passes through two processes, each must be costed separately

Plural-group Type —In the diagram (Fig 50) the plural-group type is represented by D Five machines are shown, and it is assumed that two of them (1*a* and 1*b*) are identical, while the other three are different (2*a*, 2*b*, 2*c*) though identical among themselves It will be observed that each of the machines has its own independent intake and delivery point Though for costing purposes they are grouped, this grouping has no bearing on the work they do Each machine may work on entirely different material and at any speed required

It will be evident that we have here a condition which is virtually equivalent to *two* departments of the single-series type But as, for administrative or other good reasons, they form a single department, this must be faced and the costing methods adapted to the actual circumstances

The first step will be to collect the service factors for the whole department Having assembled these, they must be so divided between the two groups (1*a*, 1*b* and 2*a*, 2*b*, 2*c*) so that each group bears its own proper share of the services provided In other words, two *independent process rates* will be required, as a single department process rate would no longer apply to all the machines indifferently If there are three groups, three rates will be necessary, and so on The method of allocation is described elsewhere

Within the groups the process rates will be identical, inasmuch as the machines are all precisely alike and, therefore, must have an identical call on service Thus 1*a* and 1*b* will have the same process rate and so will 2*a*, 2*b*, 2*c* But the rate of 1*a* will not be the same as that of 2*a* (It might happen so by an accidental combination of circumstances, but in general each group would have a different rate)

As an example, we may assume that the total of standard service factors (overhead) for the whole department was $2,000 for 1 month, and that this was found to be allocable between the groups thus

Group 1	$950	Group 2	$1,050

If the department's working hours are 200 for the month, then the total working hours in each group will be

Group 1, $200 \times 2 = 400$ hr Group 2, $200 \times 3 = 600$ hr

The hourly process rate for each individual machine will be

In group 1	$ 950 − 400 hr	= $2 375 per hour
In group 2	1,050 − 600 hr	= 1 75 per hour

The results of a month's working may be stated as follows

Group 1 worked 100 per cent of standard time, viz, 400 hr
Group 2 worked 93 3 per cent of standard time, viz, 560 hr
Group 3 wasted 6 6 per cent of capacity by idleness, viz, 40 hr

In terms of cost the results would be

Cost of jobs done by group 1 machines	400 × \$2 375 =	\$ 950
Cost of jobs done by group 2 machines	560 × \$1 75 =	980
Cost of wasted capacity (preventable idleness) in group 2	40 × \$1 75 =	70
		\$2,000

If the cost of individual jobs or lots were required, which would depend on time taken on each job, then the usual time record at each machine would be kept

Plural-ultimate Type —When there are a number of dissimilar machines of all kinds and capacities in a department, as is frequently found in machine shops, then each machine will require an individual process rate In the diagram, E represents a condition of this kind There are five machines, each of which is different from the others, and each of which has its own intake and its own delivery point It thus works with complete independence of all other machines and may be considered as virtually forming a subdepartment in itself, as far as costs are concerned

In a department of the plural-ultimate type it is obvious that there cannot be any departmental process cost, since there is no uniformity in processes but the greatest possible diversity It is, in fact, the *ultimate* or final diversity and no greater degree of diversity between processes can be found In the same way there can be no group process rates where every machine is different from its neighbours, and, should two or three of them happen to be alike, they may be considered as different, though, when the individual process rates are worked out, similar machines will have similar rates, provided they are similar *in all respects*

In this type of department the total of service-factor charges (overhead) is divided among all the machines in proportion to the call of each on each separate service Instead of a departmental total which is divided by departmental standard hours to form a standard departmental process rate, we now have a set of individual totals, one for each production center (machine) which, when divided by the standard working hours, gives a process rate entirely individual to one such center As *all* the

departmental overhead is divided up in this way, it follows that we have virtually split up the department, for costing purposes, into as many subdepartments as there are separate production centers

Figure 50 at E 1, E 2, E 3, etc , shows the general effect of this procedure The machines 1, 2, etc , which are mingled indiscriminately in one shop at E are now, in theory at least, each set in a separate department of its own, E 1, E 2, etc But if we compare this arrangement with the diagram at A, it will be seen that what we have done is to reduce the mixture of machines to separate *single-process departments,* each with its own department rate and each capable of working at any desired speed, with separate intake and delivery point, just like any other single-process department

Comparison with Little Shops —In Part I the case of a primitive type of industry was considered, beginning with a number of independent little shops, each with its own separate cost system, and then proceeding to consideration of what happened when all the little shops were consolidated into one concern, with the substitution of hourly burden or percentage methods of costing for that originally used, and the final organization of a cost system in which each separate production center (representing the former separate little shops) was again placed on an independent footing for costing purposes by the introduction of individual process rates

It will be understood from the foregoing discussion of the diagram (Fig 50), that, to begin with, the little shops were actually in the condition exhibited by the machines E 1, E 2, etc By reason of the consolidation they were thrown into a conglomerate similar to those in E, and then were restored to the condition E 1, E 2, etc , by dividing up all the overhead by means of service factors, thus enabling hourly process rates for each separate production center to be restored

Effect of Departmentalization on Costs —In the example given in Part I, the whole of the plant was considered as forming one department with eighteen dissimilar machines No departmental subdivision was made But to a certain extent the separate floors might have been considered as so many separate departments, and, as a matter of fact, the calculation of the transportation and superintendence factors was made on a basis which took into account differences between the floors To avoid

complexity, this question of departmentalization was ignored, but it could not have been done if it were the fact that departmentalization makes any difference to the final calculation of process rates.

It does not. *As far as costs are concerned*, departmentalization is merely a device for the much easier collection and the closer control over items. By narrowing down the assembly of service-factor charges to individual departments, they take on a much more concrete and practically controllable form. Moreover, certain items are in themselves strictly departmental in origin and scope, such as the salaries of foremen and other departmental employees. It may happen also that internal changes take place in a department that affect merely local calculations and do not disturb those of other departments. For these reasons, and because departments are natural subdivisions of a plant that are understood by everyone (that is to say, executives and others generally think in terms of departments), departmentalization is a most valuable assistance in the organization of a cost system. Though it can be dispensed with, it is only at the expense of greater complication in accounts and considerable loss of ready control over the interpretation of what the figures of any period reveal.

In the case of single-process departments, there is no possible escape from departmentalization. The process being naturally isolated, it would be the height of foolishness to intermingle its accounts with those of any other process. The above remarks are intended to apply rather to those types of plant in which dissimilar machines are found, and most departments contain them. In such cases departmentalization *can* be ignored, but it is by no means good practice to do so.

Process Rates Represent Uniform Conditions.—Study of the diagram (Fig. 50) will show that the number of process rates required in a given department will depend on the degree to which uniformity of conditions exists. If service factors are shared equally by all machines, as for example, if each production center occupies the same space, takes the same amount of power, etc., then only one process rate will be required, namely, that of the department as a whole divided by the total working hours of all machines.

In the single-series type A, as there is only one producton center with one delivery point, uniformity is at its maximum

There being no other production centers to share in service factors, there can be no question of any dissimilarity of call on service There can be only one process rate in such a department

In the single parallel type B each production center being alike, their call on services must be alike Consequently, their rates must be alike, and (with three machines) each rate will be one-third of what a departmental rate would be if one were calculated Perfect uniformity exists between the individual share by each machine of any particular factor, and their share of all factors together must necessarily be similar

In the plural-group type D dissimilar conditions appear Group 1 does *not* make the same call on every factor that group 2 does The dissimilarity may be confined to a single factor, as for example, if group 1 machines took double the amount of power compared with those of group 2, though in all other respects they were similar As soon as dissimilarity in the call on services makes its appearance, then more than one process rate becomes necessary, since no departmental rate can be subdivided to meet the case

Finally, with the plural-ultimate type E dissimilarity arrives at the maximum Each and every machine makes its own individual call on each service Consequently, there are as many process rates as machines Again, this dissimilarity might be confined to the call on a single kind of service Each machine might differ as to the space occupied, or as to the amount of power used, etc , while uniformity might exist in all other respects, but, generally, in this type of department more than one factor will be affected, although whether this is actually the case is a matter of no importance whatever

Conclusion—The subject of departmentalization has been dealt with at some length, not only on account of its importance but also because the influence of the layout of productive machinery (or rather its grouping) on the form in which cost should be expected has received very little attention From all points of view the isolation of processes by departments leads to the greatest simplification in costing arrangements With the single-series or single-parallel type working at a constant processing speed, there is only one variable to consider, *i e*, utilized capacity Either the full standard working hours have been employed in processing or they have not In the latter case the value of the

wasted capacity is found by simply deducting utilized hours at standard rate from actual overhead in burden account.

If the speed of processing is not constant, then it will be necessary to record actual time on each lot, job or order, and the total of such time deducted from total overhead in burden account leaves the value of preventable idleness. No simpler costing methods than these can be found.

With the inclusion of dissimilar production centers in one department, complication in costing begins. At least two process rates must be substituted for the simple departmental rate, and, in the case of the plural-ultimate type, a large number of separate rates may be necessary if accurate costing of each process is desired. This implies some considerable calculation as compared with single departments, but that is not the chief drawback. The more dissimilar machines there are in a department the more likely is it that changes may take place upsetting all the process rates and necessitating fresh calculation. It is not to be understood that such calculations are difficult or that they consume much time to make, but if they can be avoided so much the better.

If there is a large number of really dissimilar machines, there is nothing to be done but accept the situation, but if many of them are alike, and the exigencies of the business permits such similar machines to be grouped, so as to give rise to departments of single-parallel type B, then by so much will the costing be simplified and economized.

CHAPTER XIX

INCLUSION OF DIRECT LABOR IN PROCESS RATES CONSOLIDATED RATE

The discussion of how far productive labor may be made into a special service factor and thus incorporated as an element in the process rate may be divided into three heads First, the case in which there is an operator at daywork attached to each machine Second, where the said operator is paid by piecework or its equivalent Third, where operators are employed in a single-parallel type of department (B, Fig 50) and are working in a group or gang and not attached individually to definite machines This kind of working is sometimes termed "semi-direct" labor

Advantages of Consolidation—Before considering the conditions under which a consolidation of direct or semi-direct labor with the process rate is *possible*, we may discuss the *advantages* to be obtained by so doing If, for example, a certain process has an hourly rate of \$1 and the operator (on daywork) has an hourly wage rate of \$0 70, then, if direct labor is consolidated with the other factors, we could have a combined rate of \$1 70 as an inclusive cost for the process That is to say, such a rate would include every item of productive cost that can possibly be considered as legitimate

It may be said at once that the principal advantage accruing from a consolidated rate of this kind is convenience and economy in accounting (except in the case of group or semi-direct labor, wherein other advantages accrue) In costing we have only one hourly rate to multiply by the hours worked on each job, instead of two For estimating purposes this is also true In the preparation of an estimate a good deal of calculation is obviously saved if there is only one multiplication for each item instead of two separate ones The detail is, in fact, saved just where it is most numerous and least significant There is exceedingly little advantage gained by splitting cost into two parts when it can be avoided, and the practice has no doubt arisen from the old viewpoint of considering direct labor as the one definite and reliable

element in cost and all other elements (overhead) as being simply not direct

But as a process rate is a perfectly definite and exact measure of that portion of total cost which is included in it, namely, overhead as represented by service factors, there does not seem any advantage to anyone in making a distinction between process cost and direct-wage cost No particular value for estimating purposes seems to be secured by the knowledge that out of a total process rate of $3 70, 70 cts is for direct labor and the remainder for other services We are speaking here of the use of the information in relation to costs, not in regard to production engineering For the latter purpose this knowledge is of value, but not in relation to particular lots of work The production engineer would always have at hand the composition of the machine rate and would know it contained 70 cts worth of direct labor If he were considering the question of substituting cheaper labor, all the information would be at hand in that respect But for accounting purposes the important matter is that $3 70 is the inclusive cost per hour of a particular process and no advantage follows from splitting the amount into two portions

Standardization Involved —It must not be overlooked, however, that if direct labor is to be included in process rates, it must, like all other service factors, be made the subject of standardization The standardization of rates of wages for particular kinds of work is, in recent years, not an unknown practice The underlying idea is that for work of a certain character there is a certain natural rate of wages depending on the conditions set up by the work itself Skill, endurance, exposure to unpleasant surroundings, etc , are the elements which enter into the question of a proper standard of pay for the work in question There will be a normal rate for unskilled labor on ordinary work and this will form the point of departure We are not concerned here, however, with the *calculation* of standard pay, but only with the fact that it is becoming a recognized practice, and there does not seem any good reason why all work of an ordinary recurrent character should not be standardized

Two Kinds of Standardization —In Chap IX the subject of standardization of direct-wage cost was discussed at some length It will be remembered that such standardization was therein shown to be of two kinds, one referring to the wage *rate* appropriate to the job and the other to the standard operation

time it should require. Combining the two we have a standardized direct-labor *cost*.

In the present discussion we are concerned with only one of these standardizations, namely, that which refers to the appropriate *wage rate*. Whether or not the further step is made does not affect the present argument. Moreover, the relation of wage rates to the job is not under discussion. The standardization now being considered is the association of a particular wage rate with a particular process, that is, a particular machine in most instances. This wage rate, as remarked above, will naturally have relation to the degree of skill or other special qualification involved in performing the work.

Problems Arising from Consolidation.—Assuming that the rates of pay appropriate to each production center have been standardized, we have now to consider what new problems are thereby created. The behavior of the consolidated process rate under various circumstances must be studied, as well as the normal behavior under ordinary conditions.

Among these circumstances will be the following: preventable idleness, short time working, overtime, and the case wherein an operator is temporarily assigned to a process at a rate of pay higher or lower than standard. We have also to consider what is to be done in those cases where an operator receives a higher rate of pay due to causes apart from his skill or other special qualification, *e.g.*, increased rate of pay for length of loyal service, etc.

1. *Normal Routine.*—No difficulty arises under ordinary conditions, when the department is working 100 per cent of standard working hours. The process rate representing standard factors (overhead) being simply consolidated with the standard wage rate, say \$3 and 70 cts., respectively, each hour of work sees these amounts charged to jobs, the \$3 being set against departmental overhead and the 70 cts. against payroll.

2. *Preventable Idleness.*—If the departmental standard hours are, say 200, and a particular center works only 185, the 15 idle hours being distributed an hour here and an hour there, the resulting effect depends upon what is actually done about the direct labor. If due to a temporary breakdown, the operator may be laid off for the idle period. In this case there will be no charge from the payroll to the departmental account and no credit, inasmuch as no job is being worked on. This accurately represents what has happened.

More often, however, the direct labor will not be laid off but will simply be idle like the machine In this case the wages for the idle period will be charged from the payroll to the departmental account, but there will be no corresponding credit This is also in accordance with facts, since the balance thus left in departmental burden will be chargeable against profit and loss, as it represents waste

A third case is where the operator is assigned to some service job, such as cleaning up the machine, in order to keep him at hand until a new job is ready This implies that there will be a charge from payroll, but no corresponding credit, just as in the last instance The resulting charge to waste is justifiable on the ground that the employment assigned is in the nature of unscheduled and superfluous service, *i e*, it is not really necessary but is performed for reasons that have nothing to do with efficiency

In all of these cases it will be seen that the portion of consolidated rate which comprises direct labor falls into its own place automatically and presents no embarrassment under circumstances of preventable idleness

3 *Overtime* —The question of overtime is complicated, when consolidated process rates are in question, by the usual practice of paying extra, say, time-and-a-quarter, for the work done in overtime hours This does not, of course, affect the service factor ($3) portion of the rate, but it does affect the direct-wage ($0 70) portion It is evident that, if the rate is charging 70 cts into cost while actually the payroll will stand at 70 + 17½ or 87½ cts, there will be left a balance in departmental burden account of just this 17½ cts In other words, the extra rate of pay will not be charged against the job but against profit and loss

Quite apart from the question of process rates, the plan of charging the *extra* expenditure on direct labor to a general fund of some kind, instead of permitting it to increase the cost of the particular job that happens to incur it, is favored in many quarters In this case the amount of the extra pay is collected in one account and may be distributed along with other burden on any of the usual methods It is thus spread over all the jobs current in the period instead of confined to the unlucky job that happened to be processed in the overtime hours

With process rates this procedure can be followed only if overtime is predetermined in amount over a considerable period

(*cf* Chap XIV) Under such circumstances it would be possible to set up a special factor increasing the rate of such processes as were affected But in cases where overtime is sporadic, that is, occasional and accidental, due to a desire to clear up arrears, etc , we may very well regard the extra pay rate as waste, since *under these conditions overtime involves a loss of efficiency compared with standard* Instead of charging against particular jobs, it can, without substantial injustice, be charged to profit and loss direct But, when overtime is prolonged and deliberate, arrangements should be made to modify the process rates concerned

4 *Temporary Assignment at Higher Wage Rate*—If the standard wage included in the process rate is, say, 70 cts and, for reasons unconnected with efficiency, an operator at 75 cts is temporarily assigned to the process, the charge from payroll to burden accounts will be 5 cts per hour *more* than the corresponding credit by costs The 5 cts will, therefore, be charged against profit and loss This is in order, since the wage rate was in excess of standard needs, and, therefore, to the extent that standard is exceeded, can only be regarded as waste

5 *Extra Rates for Seniority*—In some plants wage rates may be somewhat unequal for the same class of work, owing to certain operators receiving higher pay in recognition of length of service or other special cause for reward If such operators are permanently assigned to certain processes, it is an easy matter to include the actual wage rate in the process rate, by which procedure the job would be charged with the full amount of the operators' wage, including the extra payment for seniority

If, however, operators are for any reason frequently moved from one process to another, then each process rate must necessarily be based on the ordinary wage rate of the class This would result in the extra payment for seniority being left in burden account and not transferred to any job Theoretically, there is much to be said for this latter method, since it can be argued that such extra payments have nothing to do with the standard cost of jobs and should, therefore, in any case be borne by profit and loss The payments of this kind usually do not amount to anything considerable and no substantial injustice is incurred by allowing them to go to profit and loss instead charging them to an individual job

Consolidated Rate with Piecework—Hitherto we have been considering the simple case of a department in which each

process has its own operator, paid at a day rate, and the consolidation consists merely in adding the wage rate, say 70 cts., to the standard process rate, say $3, making a consolidated rate of $3.70. We have now to consider other combinations of operators and processes, the first of which will be that of the operator paid by piecework or premium.

We may suppose a case in which the process rate is $1 and the operator's wage rate 60 cts., making a consolidated rate of $1.60 per hour. For a certain job we may consider the piece price to be $5. If the job is actually completed in 6 hr. the wage cost will be $3.60 and the balance earned $1.40. With a consolidated rate the burden account entries will be

Service factor charges	$ 6.00	Charged into cost	
Payroll charges	3.60	6 hr. @ $1.60	$ 9.60
Payroll balance earned	1.40	Difference	1.40
Total	$11.00	Total	$11.00

This difference is obviously that of the balance earned, which is not distributable through the consolidated rate. If this balance is separately posted to the cost of the job, the two sides of the account will balance.

The operator, however, may make a loss on the job instead of a profit balance. If, for example, the job has taken 9 hr., then the wage cost will be 9 × 60 or $5.40, a loss of 40 cts. The burden account entries will then be

Service factor charges	$ 9.00	Charged into cost	
Payroll charges	5.40	9 hr. @ $1.60	$14.40
Loss balance	0.40	Difference (minus)	0.40
Total	$14.00	Total	$14.00

This difference is again the amount of the balance, but, as this is now a loss instead of a gain, it is to be deducted from the cost of the job instead of being added to it.

These two examples serve to show that while a consolidated rate may be used in connection with piecework, it is necessary to calculate the wage cost of the job just as usual, and then add or deduct the balance from the job in the ordinary way. Where piecework is in general use, it is questionable whether a consolidated rate offers any advantages, but, on the other hand, where such rates are in general use they can be retained in those cases where piecework is employed. Whether the process rate and the wage rate are separate or consolidated, exactly the same result is

obtained, namely, an inclusive cost of $11 for the first job and of $14 for the second

Group or Semi-direct Working—It often happens that a department may consist of several identical production centers (single-parallel type) which are operated by a group of men whose work may be spread over the different centers indiscriminately The kettle floor of a soap factory or the bleach room of a textile plant are examples A set of automatic lathes or screw machines with a tool man and several assistants also come under the same category

In these cases, though the operators are in a sense working directly on salable product, the nature of their duties is such that it would be impossible to keep a record of the time spent by each operator on particular work Further, the number of men in the group may vary according to the number of parallel machines being operated but not in direct proportion Consequently, the relation of such direct workers to actual output is vague and difficult to establish by the ordinary time-sheet methods But by the use of a consolidated process rate a satisfactory solution is easily attained

Let it be supposed that there is a group of six machines, vats, kettles or other variety of production center which is rated at $1 per hour each for straight process rate It may be further supposed that this department is operated under full-time conditions by a group of 4 men whose aggregate wages amount to $2 40 per hour The consolidated rate for the department as a whole will then be $6 + $2 40 or $8 40 per hour, and for each individual machine $8 40 − 6 or $1 40 per hour

1 *Group Working at Maximum*—The principle on which our costing rests is that of maximum productive capacity To maintain all six machines in full work during standard working hours takes $8 40, of which $6 is incurred for service factor charges and $2 40 for group labor If all six machines are working 100 per cent standard hours, then burden entries will be

Service factor charges	$6 00	Charged into cost	
Direct labor (payroll)	2 40	6 hr @ 1 40	$8 40
Total	$8 40		

It is obvious that the six machines may all be engaged on one job, or each on a different job, or the work may be broken up into a considerable number of small jobs In the latter case the time

taken on each such job multiplied by the consolidated rate ($1 40) will give the individual cost of the job

2 *Group Working with Idleness* —Next it may be assumed that instead of working 100 per cent of standard time, only 80 per cent has been worked The resulting entries will be (if no reductions in service or labor have been made)

Service factor charges	$6 00	Charged into cost	
Direct labor (payroll)	2 40	4 8 hr @ 1 40	$6 72
Total	$8 40	Wasted capacity	1 68
		Total	$8 40

The amount ($1 68) chargeable to waste is obviously made up partly of wasted service-factor charges and partly of wasted group-labor charges The combined cost of manufacturing capacity was the same as in the first example, but the actual hours of operation were 20 per cent less than standard, and, therefore, the cost of 1 2 hr of capacity, provided but not utilized, has dripped into the pool of waste, as described in a former chapter

The 4 8 hr charged into cost may, as before, have been expended on one large job or divided among a number of small jobs pro rata as their time of operation This cost is exactly the same as that in the first example The jobs actually done have not cost more because some of the capacity has been allowed to go to waste

3 *Group Working with Curtailment* —In the case of deliberate short-time working (curtailment of production), the situation is much the same as in the last example, except that some economies will have been effected in the charges appearing on the left side of the account Thus, if the 20 per cent curtailment is deliberate and has been provided for, perhaps 10 per cent of the charges due to service factors may have been saved On the other hand, it is quite possible that for a small curtailment of this kind it would not be possible to withdraw any of the group of operators, especially if each of them had care of some particular aspect of the work In this case the figures would appear as

Service factor charges	$5 40	Charged into cost	
Direct labor (payroll)	2 40	4 8 hr @ $1 40	$6 72
Total	$7 80	Wasted capacity	1 08
		Total	$7 80

By reason of the reduction of service-factor expenditure, the cost of the wasted capacity due to curtailment is reduced to $1 08

instead of $1 68 as when no economics had been effected Cost of jobs remains the same as before

True Field of the Consolidated Process Rate —These examples show that the consolidated process rate has its true field in dealing with conditions such as those just discussed The vague class of semi-direct or group labor is made into a separate service factor (this of course, will be confined to its own department) and thus made part of the process rate It then takes its place along with all other services to production and, like those, is capable of division into utilized and wasted, whether or not economies have been effected to offset conditions that give rise to waste

There is very little difference between *group* direct labor of this kind and some service labor The peculiarity of group labor is that it is confined to a definite set of production centers, but certain kinds of service labor are similarly confined In the transportation factor, for example, an overhead traveler service with its operator may be confined strictly to a small group of large lathes or boring machines, but no one would regard it as anything but service on that account Similarly, though several operators forming a group or gang may be actually manipulating product, it is still merely a *service* that is being rendered to production and there is no necessity to regard it as "direct," especially when, as in this case, considerable practical advantages are secured by *not* so regarding it

Sharing of Process Rate Savings in Piecework —It has been proposed to give the pieceworker a share of savings from the process rate as well as from the wage allowance The idea is that savings on service factors (overhead) are to be shared on a 50 50 or 66 33 basis between operator and employer in addition to a similar sharing of the saving of direct-wage cost The formula for effecting this is somewhat complex, and it is difficult to see what advantage is gained It is far simpler, and much more comprehensible by the average operator, to give him the whole of his savings (piecework or premium balance) and allow the saving on process time to go to the credit of the firm

In the example of piecework under consolidated rates given above (p 223) the piece price for the job was $5 As the operator's wage rate was 60 cts , this implied a time allowance of 8 333 hr for the work If the full time were actually taken (*i e* , if no saving were made by the operator) the results would be

Process rate, 8 333 hr @ $1	$ 8 33
Wages, 8 333 hr @ 60 cts	5 00
	$13 33

and if the time taken were, as in example, namely, 6 hr, the results would be

Process rate, 6 hr @ $1	$6 00
Wages, 6 hr, @ 60 cts	3 60
	$9 60

There has thus been a *total* saving of $3 73, of which, under ordinary conditions, $1 40 is given to the operator and $2 33 retained by the firm This $2 33 is the amount of the difference between 8 333 and 6 hr of process rate

This latter amount ($2 33) will vary in proportion to the process rate That is to say, if the operator's wage rate and the piece-work price were as in the above example, the amount ($2 33) will be greater or lesser according as the process rate is larger or smaller than $1 an hour It is observable that the operator has no control of or influence on this difference It depends entirely on the machine or other production center at which he is working The *same amount of extra skill or energy* exhibited by him will bring him the *same monetary results* whether he is working on a $3 machine or on one rated at only 80 cts But to the firm there will be a much greater saving accruing from the saving of time on the $3 machine

The only deduction from this that has any practical importance is that the larger the process rate the less the objection to the operator making a very large balance, because this only implies that the saving to the firm is becoming greater and greater With reasonable accuracy in rate fixing, it is the opinion of the writer that straight piecework is the simplest, most comprehensible and most satisfactory method of payment by results If rates are fixed for the average man, then large balance earnings are due to individual and peculiar adaptability to the job The payment of such balances should not be grudged, since it is impossible that all the advantage should be on one side The firm must in any case gain in two directions

1 Saving in time of operation means saving in the amount of process rate attached to the job The higher this rate the more saving accrues to the firm

2 The quicker movement of jobs past the delivery point is equivalent to an increase of the total capacity of the machine or production center without extra expense

It may be argued that the operator should share in these additional advantages, and this is the position taken by the advocates of sharing process-rate savings as well as wage savings This is all very well in theory, but in practice all we are concerned with is a stimulus which will be psychologically effective It will matter very little to the operator whether his balance of $14 comes from a combined savings formula or from a straight piecework balance, but he will certainly understand and probably respond better to the latter Notwithstanding the theoretical points in favor of complicated schemes of reward, it would appear that the old piecework price method is still to be preferred in most instances

There is also much to be said for departmental bonuses on production, but these are altogether outside our present inquiry and will be dealt with elsewhere

Conclusion —The possibility of consolidating any given process rate with the wage rate usually associated with it has been shown, but, except in one instance, the advantage of so doing is confined to simplified calculation

On the other hand, where group working is employed in a department in such a way that a number of similar production centers are served by a group of men, working at large, the method of throwing all such semi-direct labor into a labor factor and making it part of a process rate is considerable Costing of this character can be done in no other way so simply and satisfactorily

Proposals to share savings on service factors (overhead) as well as on direct wages under piecework or premium working have been considered, but the plan has been shown to offer no particular advantages from a practical viewpoint, while it is necessarily complicated to apply

CHAPTER XX

CHARACTERISTICS OF THE PROCESS DOLLAR

The relations of the process rate to overhead and to production and its behavior under varying conditions of business having been considered in some detail in the preceding chapters, a general summary of the theory of process cost—or as we may term it by way of emphasis the *process dollar*—will now be in order

Modern Manufacturing—Two fundamental principles exist in modern manufacturing One of these refers to the way in which operations are divided up into separate and distinct processes The other refers to the fact that these processes are repetitive In pure craftsmanship neither of these principles is found The old time shoemaker carried out his work by a series of separate operations, of course—cutting out is necessarily a distinct operation from sewing or attaching trimmings—yet not only were these steps carried out by the same hand but also it is doubtful whether they were thought of as more than stages, dovetailing into one another, in the gradual upbuilding of the finished article

Isolation of Processes—Under modern conditions the unit of manufacturing operations is the *process* While this corresponds somewhat closely with the old formula of the *division of labor*, the stress is more properly put today on the process itself rather than on the labor that enables it to function Division of labor formerly implied subdivision of *skills*, but today it implies, in most cases, division among a series of special machines In such cases the labor is very often, and to an increasing extent, practically unskilled and can be shifted from one subdivision of the process to another indiscriminately Special skills are more and more being transferred to special *machines*

Modern manufacturing, then, consists of a series of separate, distinct and isolated processes, for the most part carried on by types of machine individual to each process Even where this latter condition is not wholly present (as in certain types of machine-shop work wherein a series of, say, milling machines may

be carrying out different operations on the same product) there will frequently be some special jig or attachment to each machine which assists in differentiating it from its neighbor, so that, after all, each machine has an individuality and could not *without alteration of some fixture or accessory* be used for the next process in the series

This being the case it is not too much to say that what constitutes a particular industry is the whole series of processes set up for the transformation of raw material into finished product Each industry has its own processes, though two or more industries may have similar processes, differently combined to produce different effects, working on different material In general, however, the statement is true that an industry is recognizable by its processes and by nothing else All plants have buildings, consume power, contain storage, have arrangements for moving material to and fro, employ administrators of several grades, make use of offices and office forces, and to know that this is the case in any particular instance does not give us any key to what the industry is

But as soon as we come to enumerate the processes carried on—if we speak of soap kettles and tallow tanks, or of mercerizing machines and dye vats, or of gun lathes and tempering pits, or even of milling machines and shapers— some measure of identification of the industry appears at once and has only to be carried into more detail to make the identification complete Processes are the keynote of modern manufacturing and this, and not any question as to the division of labor, is the viewpoint that should be adopted in considering the facts of modern production

Repetition or Recurrence—The most significant fact about the employment of processes is that, for the most part, they perform exactly the same operation over and over again Even though a diversity of material may be worked upon, what is done to it by any one process will be a change in its status that will be of similar character Thus, a steam hammer or a forging press may work on a billet of steel or a bar of wrought iron, a soap kettle may boil a mixture for a coarse household soap or a fine toilet soap, a dye jigg may be working on a thin voile or a heavy duck, a milling machine may be used on an iron or a brass casting, but in each of these cases the *process* itself is identical It may take a longer or shorter time for one of these materials than for another to pass a similar stage of manufacture, but

otherwise there will be, usually, no difference in the call on service factors

Further, hour after hour of process work on a machine sees nothing but repetition of the same detailed performance Today, or a year hence (provided that no *change* in the process has been made meanwhile) an observer watching the process will see a precise repetition of the movements, the same call on space, power, transport and other service factors, the same procession of work past a delivery point, and, in short, an unchanged succession of events, whatever these may be, that constitute that process

Recurrence of Expenditures —In the present inquiry we are not so much interested in the repetition of technical operation details as in the fact that such repetition implies a recurrence, period by period (*i e*, in the last analysis, hour by hour), of precisely similar items of *expenditure* in precisely similar amounts In other words, the cost of running a machine in a condition of preparedness to do process work is the same in any one hour during the year as in any other hour

It may be asked How are we assured that the kind and amount of service *is* the same? The answer is that if it were not so, an *alteration* in the process must have taken place If service equivalent to the value of $1 is sufficient to maintain the process in one month, it must be sufficient to maintain it in any other month, provided the cost of space, power, etc , has not increased in the meantime And if such an increase in service factor cost (overhead) had occurred, *all processes would be affected and not one only*

Hence, if a process rate is determined accurately for one portion of a financial period, it is good for any other or all portions of that period, while the process remains unchanged and no alteration in service cost has taken place affecting all processes in the department

Different Plants Have Different Process Costs —It does not follow that because a certain process is found to have a process rate of $1 55 in one plant, other plants with a *precisely similar* process must also rate it at $1 55 It will rarely be found to be the case

Consider what such an agreement would imply The cost of each kind of service would have to be the same to begin with The space factor, for example, would have to be built up of

similar expenditures, or at least to a similar total, yet the elements, cost of land and buildings, or rent of same, the cost of heating and lighting, of labor for various purposes might be quite different in two instances The same would apply to the power factor, wherein the cost of fuel, water, and labor, a different type of power equipment and different methods of transmission would bring out quite different power-factor rates The other factors would not, perhaps, be liable to differ so widely, but sufficiently for the total result to be unlike that of a competitive plant

In all competitive undertakings the chances of a new plant entering the field may usually be summed up algebraically That is to say, some conditions will be more favorable than those of existing plants and some less The net sum will determine the success or failure of the new undertaking In computing such chances the classification of all overhead expense by service factors will be of considerable assistance, particularly where other plants in the same field have adopted the same method and the average figure in each case is known

The Process Dollar —These interrelations of the (overhead) service factors may be symbolized by what we have termed the

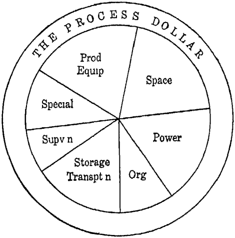


Fig 54

process dollar The process dollar is the emblem of all that class of expenditure that does not come under the description of "direct" labor or material As will be seen from Fig 54, it is

composed of arcs or segments representing the different service factors, the arc occupied by each factor being in proportion to the relation of that factor to the total. Wherever the process dollar is considered, whether as issuing from the delivery point of a single process department or from the delivery point of individual production centers in a plural ultimate-type department, it has the same constitution, but the proportions of the various factors will, in general, be different.

Omitting the question of direct material (and, as has been mentioned, there are several examples of industries which have no direct material in the cost sense), it may be said that the process dollar and the direct-wage dollar, between them, comprise all the recurrent, that is, all the legitimate expenditure on production.

In the past the attention of the manufacturer has been focused almost entirely on the direct-wage dollar and very little on what is represented by the process dollar. This is quite natural, inasmuch as the relation of most of the remaining expenditure (indirect) to cost of production was vague and hard to perceive. Direct wages, and in particular the reduction of direct wages, became the principal subject of meditation whenever the necessity for more economical production made itself felt, and a cost was commonly said to be "reduced" when some lessened amount of direct wages became attached to each unit quantity.

This frequently erroneous viewpoint was assisted by the errors introduced by the ordinary percentage systems of burden distribution, which in so many cases simply falsify the true relations of overhead to cost of product.

A more correct way of regarding the facts of production cost is to consider that, in every process wherein there is any direct labor at all, the process dollar and the direct-wage dollar are side by side and entirely independent. Either of them may be increased or diminished without affecting the other, but with close connection with the cost of unit product.

Origination of the Process Dollar.—If we consider the plant as a whole, it will be recognized that the whole cost of each service (factor) required to maintain the plant in a condition of preparedness for production can be set against each segment or arc of the process dollar, and the total cost of manufacturing capacity thus obtained will be the full circle. This will represent the constitution of the process dollar, that is, the proportion in which the various services are intermingled, for the *plant as a whole*.

Similarly we may assemble the percentage of factors for each department in the same fashion, and this will give the constitution of the process dollar for *separate departments* This constitution or "makeup" of the dollar will usually be quite different as between departments and also as between departments and the whole plant

Finally, in the case of plural departments the process dollar for each separate production center may be set up (Compare Fig 56, which shows that these constitutions of the process dollar differ in some respect for each such center)

As all of these different percentages of service, when reduced to monetary values, give rise to different *total* values, different hourly rates are originated Consequently, a single process dollar will represent very different amounts of *time*, according as we are considering its value for the plant as a whole, for a department, or for individual production centers in a plural department As applied to the plant as a whole, one process dollar may represent only a matter of seconds of operation As applied to a department, it may be equivalent to minutes of operation, and, as applied to individual production centers, it may represent anything from a few minutes to an hour or more of process operation

Time Value of Process Dollar —Figure 55 exhibits this aspect of the process dollar A small plant is shown which is divided into four departments, two of which are single-process departments and the other two plural ultimate-type departments having a process rate for each production center

To begin with, the plant *as a whole* is absorbing service at the rate of \$50 an hour, which is equivalent to 1 2 min production for \$1 Unless the product were perfectly uniform (such as one kind of paper), no useful connection between process cost and output can be made at this stage And even if the product were perfectly uniform, such a plant process cost would throw no light on the cost of departmental processes

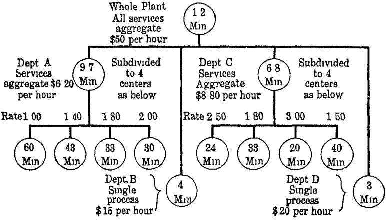
The next stage at which the process dollar appears is in departmental cost The four departments absorb service as follows

Dept	Per Hour
A	\$ 6 20
B	15 00
C	8 80
D	20 00

The $50 per hour absorbed by the whole plant is thus absorbed in different shares by each of the four departments.

Departments B and D are single-process departments. In one case 4 min. of processing are given for $1 and in the other case 3 min. No further subdivision of process cost is possible in these two departments.

In departments A and C, on the contrary, the department cost means nothing, just as the whole plant cost would mean nothing save in the case specified above. It means nothing because processing is actually carried out through four delivery points in each instance, and each of these has a different process



NOTE—It is assumed in this diagram, that all departments have the same number of standard hours.

FIG. 55.

cost. For the departments, *as units*, 9.7 and 6.8 min., respectively, of processing would be given for $1, but the actual amount of time given at the delivery points for $1 varies from 30 to 60 min. in the case of department A and from 20 to 40 min. in the case of department C.

Leaving the whole plant rate and the department rates for A and C out of account, it will be seen that the *amount of time given at delivery points for one process dollar* ranges from 3 to 60 min. in this plant. In a great many cases the range will be very much greater than this.

Process Dollar and Waste.—We may picture the drip of process dollars from delivery points at the end of each number of

minutes, as indicated by the figures within circles in Fig 55 For the whole plant a process dollar drips every 1 2 min, but from the delivery point of production center 1 in Dept A, an interval of 60 min between the drips takes place As above explained, the whole plant has no delivery point, except under very special circumstances which are infrequent, and, therefore, we need consider only the individual production centers in Dept A and C and the single process Dept B and D There are, therefore, 10 delivery points in all, the process rates for which vary from $20 to $1 per hour, or, alternatively, give from 3 to 60 min processing operation for $1

It was pointed out in a former chapter that the drip of process cost from each delivery point had two destinations Either it fell on to jobs and became cost of product or it fell uselessly into

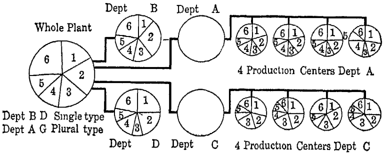


FIG 56

what was termed the "pool of waste" In this latter case it became a dead loss and must find its way sooner or later into profit and loss account Regarding Fig 55 from this viewpoint, the practical deduction is easily made that in surveying all the delivery points in a plant there is a very great difference in the degree at which waste takes place when such delivery points are idle Three or four minutes idleness in some cases produces as much waste as a whole hour's idleness in another case The necessity for avoiding idleness has, therefore, different degrees of urgency The shutting down of Dept D for a single hour leads to greater loss than would arise from the shutting down of all the four production centers in Dept C for 3 hr

Constitution of the Process Dollar—Figure 56 shows the same plant as delineated in Fig 55, but a general view is given of the makeup or constitution of the process dollar, according as it

represents a departmental or an individual production center expenditure

It will be understood that this diagram does not deal with the *amounts* of capacity represented by each process dollar but only with the way in which the various services are combined all over or throughout the plant so as to provide maintenance of manufacturing capacity at the various delivery points

The principal deduction from this diagram is that the proportions in which the different service factors enter into the constitution of any given process dollar is only one of the elements of cost The space factor, for instance, may be 20 per cent of the whole, but the actual value of this space factor is a quite separate matter and will depend (1) on the amount of space actually occupied by the department or production center and (2) on the annual cost of this particular area In other words, the process dollar is not a mere arithmetical ratio but is *a cross-section of the flow of service* into the department, or center, of which the inclusive value is one dollar

A process rate and, consequently, a process dollar may have a very different constitution and yet be equivalent or nearly equivalent to another rate or dollar Thus, for example, we may have a department (or center) in which there is

Large space occupied,
Small power absorption,
Large individual equipment factor,

and another department (or center) in which there is

Small space occupied,
Heavy power consumption,
Moderate equipment factor

Although the composition or constitution of these two rates is very different, the actual total, when all services are summarized, may be equal or nearly equal

In the same way two centers having different rates may be made up of closely similar percentage compositions, but the actual amounts or values of service in the two cases may be very diverse.

Conclusion—From what has been said it will be understood that the process dollar is, in a sense, the converse of a process rate While the rate concerns itself with the price of the com-

bined service factors entering a department (or center) for one hour, the process dollar measures the number of minutes of service provided for one dollar

In practical calculations, therefore, the process rate is the unit that is commonly used, and it may be asked What is the importance of setting up the conception of a process dollar if its practical functions are discharged by the rate? The answer is that the process dollar provides another way of observing the facts of production A diagram of a plant arranged as in Fig 55 gives an interesting picture of what is obtained in the way of process work for one dollar at every delivery point throughout the whole plant Coupled with diagram Fig 56 it furnishes an instructive picture of the way in which the various services permeate all the productive processes and emphasizes the importance of considering process cost as a definite and important element, just as definite and important an element as direct-wage cost

Nothing has been said in this chapter as to the cases in which direct wages are consolidated with the process rate If, however, it is imagined that another sector or arc is included in the process dollar for the plant as a whole and also in the dollar for the department in which the consolidation has been effected, the place of such an arrangement will be understood In such cases the direct labor so combined becomes a service factor exactly like other factors, but its application as a component of the process dollar is, of course, confined to such departments as actually are organized on this plan It does not affect the other departments or centers at all

PART III

PRACTICAL DETERMINATION OF SERVICE FACTORS AND PROCESS RATES

CHAPTER XXI

THE TIME BASIS

In the foregoing chapters the general or theoretical lines of overhead treatment have been discussed in some detail. In Part I the broad principles involved were illustrated by examples taken from a comparatively undeveloped type of industry. The role played by service factors and process rates and the manner in which they differentiate between processes so as to give rise to true individual process cost was illustrated by numerical examples. Comparisons were also made with the results which would be attained by use of the older methods of burden distribution.

In Part II the principle of standardization as applied to both direct-wage and process costs was discussed, and the response of the process rate to varying conditions of business was studied in considerable detail. This part, in other words, dealt with the practical *conditions* which have to be met by any method of connecting overhead with processes, and it was demonstrated that, for each type of variation, the process rate either responded or could be so modified as to respond to the given conditions.

In Part III we shall proceed to the discussion of the practical *steps* to be taken in setting up service factors and process rates under the conditions of modern industry. There will then be left for study the question of verification and control of the standardized figures as compared with the actual expenditure, month by month, and the application of process rate cost to the purposes of bidding and estimating. These latter subjects will be dealt with in Parts IV and V.

Standardized Working Hours.—Before proceeding to consider particular service factors, one element which is common to all

and forms the basis on which they all rest must receive attention It has been explained in previous pages that overhead in any form is an expenditure undertaken for the maintainence of manufacturing capacity in a condition of preparedness to do work Before we can take any steps to ascertain the *forms*, *i e* , separate service factors, in which such overhead may, for the purposes of cost accounting, be collected and segregated, it will be necessary to obtain a definite idea of what capacity we are about to deal with, or, in other words, how many working hours during the year shall be considered as the standard working capacity of the plant

The Two Varieties of Overhead —It will be remembered that overhead consists of two types of expenditure, originating at two sources and having opposite relations to working hours Certain so-called "fixed" charges, as discussed in Chap X, are divisible by working hours, other kinds of expenditure are in proportion to working hours As both of these types of expenditure enter into all factors, it become necessary to determine exactly what number of working hours shall be considered as making up the standard year, otherwise it will be impossible either to divide the one class or multiply the other so as to satisfy the demand for standardization of all expenditure

Forecasting Standard Hours —One difficulty may arise at the very beginning The standard working hours in all departments of the plant may not be the same Certain departments may, from the very nature of the processes concerned, operate either 24 hr a day, or on double shifts, while others are run on the basis of a 48-hr week It will, therefore, be evident that no one figure can be obtained which can be called the "standard working hours per year" for the plant as a whole where this is the case

Departmentalization —This, however, is of little consequence inasmuch as service factors are built up department by department If in one such department the working hours are, say, 2,400 in the year, and in another they are, owing to continuous operation, 7,000 in the year, then in the first case annual charge for depreciation, interest, etc , will be divisible by 2,400 and in the second case by 7,000 Similarly, all hourly expenditures will be multiplied by 2,400 and 7,000, respectively

Working Hours in the Week and Year —The number of working hours in the year is not arrived at by multiplying the normal week, say, 48 hr , by 52 Such a calculation would give

merely the nominal working hours per annum This nominal total would have to be diminished by the amount of all public holidays and other interruptions to business The proper procedure, therefore, is to go through the entire year, with the aid of a calender, to ascertain the *actual* working hours for each month and for the whole year [1]

Where it is known that overtime will be worked during certain periods, or if it is expected, on the basis of former experience, that such will be the case, then this extension of working hours should be included in the total (see Chap XIV)

Similarly, if it is known that in a certain period production will be curtailed, only the actual expected hours and not the full nominal hours should be included (see Chap XIII)

Seasonal Operations —The cases in which the working hours must be based on the season's operations, owing to the fact that working hours are subject to violent fluctuations from the very nature of the business, have been dealt with in Chap XV and need not be further discussed here

Completion of Standardization —When the field of working hours has been carefully gone over in the way described, we shall be in possession of schedules for each separate department which show the actual working hours which are expected to be worked in each month of the year In other words, we shall have listed the expected manufacturing capacity of each department The expenditure on overhead as represented by the total of all service factors chargeable to each department will be the cost of keeping the department's processes in a condition of preparedness for the specified number of working hours We have, therefore, arrived at a standard cost of manufacturing capacity for each department

Calculation of Service Factors —Certain elements of each service factor, namely, such items as interest and depreciation, insurance and taxes on equipment in the department, salaries not on an hour basis, etc , will be chargeable to the department factors from the data on the financial books Other items, including all those arising from hourly employment, such as wages of indirect workers, will be calculated on the basis of the standard hours for the department Combination of the figures from these two sources will provide a total of annual expenditure, for each factor and all factors together, which will be the cost of manufacturing

[1] A suitable calender is suggested in Chap XXXV, time-basis control

capacity of the whole department for one year's manufacturing capacity as based on the standard working hours

Conclusion —In the ensuing chapters the building up of the service factors common to all manufacturing plants will be considered in detail These include

1 The land factor } Combination of 1 and 2 forms the space factor
2 The buildings factor }
3 The power factor
4 The storage transport factor
5 The supervision factor
6 The organization factor
7 The productive equipment factor
8 Factors additional to the above, which are found only in some plants

All of these factors, as has already been pointed out, rest on the previous settlement of what standard manufacturing capacity is concerned Together they are the price or cost of that manufacturing capacity for each department as a whole It is, therefore, a fundamental necessity to settle, first of all, just what manufacturing capacity, as represented by working hours in each department, is to be used as a basis The practical operation involved will be described in a later chapter (XXXV)

CHAPTER XXII

LAND-BUILDINGS OR SPACE FACTOR

I LAND

All manufacturing operations necessarily require land and practically all require buildings as well Provision of a site is, therefore, antecedent to all other steps in setting up an industry

Great Variety in Character of Sites—The amount of land required by different industries varies greatly Some are content with a city building of limited space or even with one or more floors in a "loft" type of building Others require single-story buildings of great extent, with either monitor or saw-tooth lighting And, apart from the extent of factory buildings, many industries demand much land space for storage, seasoning or ripening of materials, for very large coal piles, for huge oil tanks, railroad sidings or spur tracks, industrial railways or tractor roads and other purposes which are in the nature of services and not *directly* concerned with actual manufacturing processes

Unit Value of Sites—It follows that the unit value of sites may vary within wide limits In large cities, especially, the cost of land and the heavy expenditure on what may be a cramped and unsatisfactory site, allowing of no easy extension, frequently amount to a noticeable burden on manufacture The high assessments and heavy burden of taxation on such city sites have given rise to a marked tendency to remove important industries to open country where land can be acquired at something like agricultural values New industries, also, which anticipate a somewhat quick rate of expansion, seek sites where ample provision may be made for future extensions This tendency persists in spite of the disinclination of skilled labor to live away from the pleasures and excitements of the city

Where premises are merely rented or leased in a city, a high unit-site value is not as important as where, on a costly site, new and permanent buildings are set up for a manufacturing purpose In the former case removal from the expensive conditions is much more easily effected than in the latter, since it may prove difficult

to dispose of buildings suitable for the original purpose but less satisfactory for any other that offers In general, caution should be exercised in tying up to a site that does not permit of expansion, and of which a high unit cost is not compensated by other advantages

Low Unit Value Not the Only Consideration —It must not be overlooked, however, that low unit cost of site is not the most important matter when selecting a location A site that is inaccessible is obviously barred Access to raw materials is essential and nearness to markets equally important The pressure of these conditions naturally varies according to the nature of the industry proposed to be carried on In the case of "heavy" industries, wherein transport plays a controlling part, they are more important than in, for example, an airplane factory or one devoted to the manufacture of light mechanism carrying much value in little bulk

Much also depends on the character of the labor to be employed Some classes of business, requiring the proximity of large reserves of unskilled labor to be drawn on at short notice, cannot be carried on away from crowded centers of population

The scale of operations and the degree of access to capital are also important influences on the choice of site A comparatively small plant must of necessity locate itself in the neighborhood of an existing town where housing and marketing accommodation for its employees can be obtained, though it is true that the cheap automobile has greatly widened the area falling within this demand But, in any case, a concern about to be established on a very large scale, with ample capital, is more independent, as regards its choice of site, than any small enterprise can be Such a concern can, and frequently does, provide not only its own manufacturing erections but also undertake *the function of a speculative landowner* by erecting a model village with all necessary housing and marketing accomodation and the adjuncts demanded by the social life of a modern community

It is no part of the present enquiry to consider the pros and cons of site selection further than to note some of the different elements that may enter into a mature judgment Interest in the matter commences when the site has been acquired and the value it represents has been placed upon the books Whether this value is high or low, whether it represents a simple building site or is a great tract of land to be used for many purposes makes no

difference to the manner in which it is related, ultimately, to production cost, because the first care will be to map out its actual uses, whatever these may prove to be

First Step in Setting Up Land Factor —The first distinction, therefore, in commencing the determination of the land-buildings or space factor is between land used for *bona fide* manufacturing purposes and all other uses

1 *Reserve Land* —If a large area of open land has been acquired, it will be fairly certain to include some purchased in view of future developments but not yet in occupation for manufacturing purposes of any kind The acquisition of such reserve land is in the nature of a prudent investment, even though not immediately a productive one It may even happen that such land retains its agricultural or horticultural value for grazing, truck farming or similar purposes, in which case it would, of course, produce a small revenue It is obvious that a land area of this kind must be made the subject of a separate accounting Interest on the capital investment and the taxation on the area will be set against any income that may be derived by letting it for agricultural or other purposes, but none of these items should be mingled with the manufacturing accounts *Only when such land is actually taken over for some manufacturing purpose can it be permitted to enter into a service factor* Until this happens any net outgoings on the land in question are a charge against profits but are certainly not any part of manufacturing expenditure

2 *Community Land* —In the same way the value of all land areas which are devoted to housing schemes, parks and playgrounds, etc , should be rigorously segregated In cases where these features are extensive it is advisable that estate development should be handled by a separately organized corporation, under which circumstances no confusion in accounting is likely to arise Losses are frequently incurred in such schemes, which losses may be unavoidable and even, in a sense, for the good of the concern, but they cannot be regarded as in any way chargeable against production They must be met out of profits directly and not in the indirect way of first charging them into any form of overhead and thus into costs

3 *Service Areas* —Having eliminated all such areas of land as are not directly occupied by productive activities of some kind or other, the next step will be to distinguish between areas occupied by actual processing, such as the space covered by a foundry

or a machining department, and areas taken up *for service purposes*, such as a coal pile, a yard for storing steel billets, a lumber pile, all roads, tracks and runways, and space occupied by service departments, such as a power house These service areas must be carefully mapped out so that the acreage devoted to each particular service purpose is separately ascertained

4 *Processing Department Areas* —Usually when the foregoing three varieties of area have been separately considered, what is left will be occupied by actual processing departments Such areas will, in general, be occupied by buildings, but in some cases processing areas will be occupied by pits, sunken vats or tanks, open air racks, etc , in which certain varieties of process work are carried on Whether buildings or other erections are occupying the area is of no consequence at the present stage, inasmuch as all that is required to consider is the use to which the area is put, namely, whether for actual processing or not

Land Schedule —When the whole area belonging to the firm is thus mapped out, we are in a position to construct a land schedule, which is, in effect, a form or blank on which the dimensions and capital values of the different areas are set down and against each the amount of annual outgoings (mainly interest and taxes) is calculated

Land values may be said to be the simplest kind of property that enters into manufacturing accounting Items which bulk considerably in the case of other property do not enter into land values Land, for example, is not subject to depreciation or obsolescence, does not require expenditure for maintenance and repair and entails no particular supervision On the other hand, these conditions apply chiefly to land which has been purchased outright, that is, of which the freehold has been acquired by the concern Where land is held on other tenures, certain complications may present themselves which must be discussed before the actual compilation of a land schedule is described

Tenures Other Than Freehold —Though, as has been pointed out, the land factor contains fewer elements than any other factor when freehold tenure is in question, other tenures involve questions of quit rents or chief rents, ground rents, mortgage interest and amortization of leases that sometimes give rise to troublesome questions Some of the principal varieties of tenure are as follows

1. *Quit Rents or Chief Rents.*—This class of tenure is more common in European practice than in the United States. It comprises practically a perpetual leasehold at a fixed rent. For all purposes of ownership the tenure is the same as a freehold, provided that the annual payment or quit rent is regularly paid. In other words, the land is acquired in perpetuity subject to an annual rent which is not subject to alteration or increase under any circumstances.

In dealing with this tenure from an accounting viewpoint, the items of expenditure or outgoings are precisely the same as those pertaining to a freehold, except that the annual rent must be reduced to an annual charge per unit area (square yard, etc.) and added to taxation, interest and other unit-area charges.

2. *Leaseholds. Ground Rents.*—In the case of a leasehold tenure, there are two important features to consider. First, a considerable sum has been paid out for the purchase of the lease, and second, during the purchaser's occupation of the property there will be an annual ground rent to be paid. Virtually, a leasehold tenure is equivalent to the payment of rent in two portions, one a large payment representing a term of years rent paid *in advance* and the other an ordinary annual rent. The latter will be a much smaller sum than would be paid for the property on an ordinary annual tenancy.

From the viewpoint of the land-factor accounting, a leasehold presents more complication than a freehold. It is property, inasmuch as the usufruct of the land is complete during the term of years covered by the lease, but every year brings nearer the date when we shall have no further rights. In other words, the property is of a wasting character. This peculiar character must be reflected in costs.

In addition to the usual outgoings on a freehold property, such as taxes and interest on investment, and in addition to the annual charge arising from a quit-rent tenure we have, in the case of leaseholds, to provide for *amortization*. Amortization is a kind of depreciation, for, as the term of the lease is a limited one and as at the end of that time the property reverts to the original owner, it will be obvious that a fund must be accumulated to replace the capital outlay by the time the lease terminates, which is, in fact, precisely equivalent to depreciation on a machine or a building. Though the land itself does not decay, the leaseholder's

right to it diminishes in value year by year as the end of the term approaches

3 *Simple Lease without Ground Rent* —The term "lease" is also applied to what is a simple contract to rent premises or land for a term of years at a given annual rent In this case the only significant feature is the rent, since nothing has been paid out on account of the lease Here the lease is only a mutual agreement to let the premises for the purpose required, on the one hand, and to pay a stipulated rent for a term of years, on the other Nothing in this differentiates the transaction from an ordinary annual rental

4 *Mortgages* —While mortgages are more common on improved property than on simple land areas, it may be well to consider here the effect of a mortgage on the accounting, if it is supposed that the purchase of the land on a freehold tenure has been made possible by the giving of a mortgage for a considerable part of the total purchase amount

Briefly, whether a mortgage exists or not has nothing to do with the land-factor accounting If it be assumed that a site has been purchased for $20,000, of which $8,000 was paid by a mortgage bearing 6 per cent interest and the remaining $12,000 in cash, it is obvious that this is intended to be a temporary expedient and is a matter of finance and not of production The land-factor value of this site would be entered as $20,000 and interest at 6 per cent would be charged into costs on this amount The fact that part of this interest goes to satisfy capital that is in other ownership is no affair of production It is precisely the same as divided ownership, that is, as though $12,000 were held by one person and $8,000 by another If later the mortgage is paid off, then the whole $20,000 becomes the property of one person (that is, of the firm itself), but these arrangements do not affect production and, consequently, are ignored in making up land factors

5 *Mortgages at High Interest* —The foregoing is the simplest case of mortgage accounting in connection with factors It may happen, however, that while 6 per cent is considered a fair rate of interest to be included in all matters of costs, the mortgage in question was raised not at 6 but at 8 per cent It will be evident that the arguments in the previous paragraph do not altogether apply to this case, and, though the annual value of the difference

is small, there is obviously a principle involved that demands a little discussion

The point in issue is this While the principle laid down in the previous paragraph holds good for 6 out of the 8 per cent involved, the question of whether the extra 2 per cent is properly chargeable to the land factor or whether it should be considered as a financial matter and so transferred to profit and loss account is still open The definite problem is Are we to consider the charges to land factor as 6 per cent on $12,000 and 8 per cent on $8,000 or as simply 6 per cent on $20,000 as before? And, if the latter, what becomes of the $160 which is the annual difference between 6 and 8 per cent on $8,000?

To solve the problem we must distinguish between the actual and permanent and the accidental circumstances as they affect production It is obvious that the mortgage is a purely incidental handicap, removeable at any time and having no real or permanent relation to cost of manufacturing The payment of a higher rate of interest on a mortgage during the life of that mortgage is a matter that stands on a totally different footing from the purchase of a site at a high *price* The latter is a permanent burden that has to be carried and cannot in any way be remedied It is, therefore, perfectly proper and legitimate to allow the influence of such high price to enter costs In fact there can be no alternative

While no amount of argument will serve to reduce the amount of expense incident on any particular area when this is due to a high purchase price, there are good reasons for the assumption that the extra mortgage charges in question are not really incident on any particularly area, nor, in fact, on any area at all The *raising* of capital in a particular way has no real connection with the way or with the purpose for which such capital is *used*

Let us consider, for example, the position of the concern at the commencement of its operations It had, we may assume, $132,000 of which $120,000 was required for buildings, equipment and working capital, leaving only $12,000 available for the purchase of the land This seems to connect the shortage (and, consequently, the extra expense for interest) definitely with the cost of land, but another way of looking at the facts will serve to dissipate that view

What really happened was that the firm had prospective use for capital up to a total of $140,000, of which it had only

$132,000 in hand For reasons of convenience, this shortage was overcome by giving a mortgage on the land for $8,000 at 8 per cent, but it does not require much consideration to infer that this method of raising the money has nothing to do with the land, as land The placing of the mortgage on the land was merely accidental The additional amount required might just as well have been raised by a bond issue or debenture security bearing on the whole business and *not on any definite unit of its property*

This example shows that mortgage interest, although it may actually be incident on particular items of property is, as regards factors and costs, exactly the same as bond interest which is necessarily paid out of profits We may adopt the principle, therefore, that payment for the use of capital made by the firm to outsiders is one thing and interest on working capital values as used in production quite another The essential and permanent feature in this case is the purchase of the land at a certain price It is this *price* which is to be treated as the capital value of the land for factor purposes In what way it is paid for, whether in cash or by a mortgage, is no concern of production but is a financial arrangement which will be adjusted when profits are available

Bearing of Site Value on Production—In the case of a new plant erected on a site that has been specially purchased, the outgoings on land account will be considered as bearing equally on all portions of the area On whatever tenure it has been acquired and whatever the nature of the outgoings, no one portion of the land can be considered as supporting a heavier incidence of charges than another—it being always remembered that unoccupied or reserve land does not enter into the land factor, although bearing, of course, its own portion of the expenditure Every square yard of the land area which is devoted to manufacturing purposes is thus chargeable with exactly the same total of annual charges, quite irrespective of the use to which it is put, namely, whether to service or to processing uses

1 *The Case of Extension*—These very simple and obvious conditions are not always present In open country where a large and sufficient area can easily be acquired, they are generally to be found, but, when considering the case of plants located in crowded areas, more complex conditions frequently exist A plant may, for example, have made extensions at various times, some of which have proved to be (as regards the site value) more

costly than others How are these additional areas to be dealt with when they come into use? Are they to modify the unit values obtaining already in the older portions of the plant, or are they to bear their own burden and represent *by means of a higher land factor* the costly conditions prevailing when they were brought into use?

2 *Consolidation of Areas*—The question is a difficult one and cannot be answered offhand It must be considered at some length, as the same principle is involved with regard to other factors besides the land factor At first sight and regarding the plant as a single unit, it may seem absurd not to consider a costly extension as increasing the land factor as a whole It might be argued that a *reductio ad absurdum* would ensue if the same process were being carried on in both the old and the new portions of the plant If a higher land factor had been established for the latter, then to that extent the cost of processing would be higher in the new portion than in the old *for exactly the same process* Although this result is perfectly true and represents what has actually taken place, it is also true, from a practical working viewpoint, that it could not be accepted Unquestionably the difference in value should be pooled in such a case, so that the process would cost the same in both places

3 *Areas Kept Separate*—On the other hand, there are circumstances in which it would be both just and wise to allow the higher factor due to a costly extension to remain independent This is particularly the case where the extension has been acquired for carrying on a different class of manufacturing process from that carried on in the older portion of the plant Suppose, for example, that the firm decides to make its own castings and, for that purpose, purchases an adjacent site at a much higher price than had been expended on the original parcel of land Two courses are open in respect to the land-factor charges (1) the old and new areas may be consolidated and one factor rate established throughout, or (2) the old portion may continue at the old rate and a new and considerably higher rate be set up for the extension area The objection to the first course is that the production costs of the old departments will be raised for a purpose by which they do not benefit and with which they have nothing to do It would not be fair to burden existing production with an extra cost because a new productive field is entered On the contrary, there is every reason why the higher factor due to

the extension should be confined to the branch of business carried on in it If it should fail of success, its closing down should not disturb the older type of production It would obviously be absurd to reduce the cost of that production because the new department had been discontinued and the site of the experiment resold

4 *General Principle* —From these examples a working principle may be inferred which may be stated as follows Where different basic circumstances give rise to factors of different value and there is no pressing, distinct and practical advantage in consolidating and averaging them, such factors should be treated separately *Unless some anomalous and distinctly impracticable result would follow from their being confined to the site to which they belong they must be so confined*

Land Factors of a Complex Site —An actual example of the working out of the land factor will be more useful if a case is

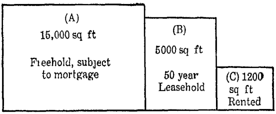


FIG 57

taken wherein more than one tenure exists, such as is not infrequently the case in city sites when a plant has been established many years and has been subject to a slow rate of expansion Figure 57 exhibits a diagram of such a plant in which the original portion A was purchased outright on freehold tenure In after years, an extension being required, it was found impossible to acquire more land on freehold, but an area B was obtained on a fifty years lease at a certain ground rent plus a sum down as the price of the lease It is assumed that portions A and B contain integral portions of the same series of processes, so that they may be regarded as one area A mortgage of $10,000 has been placed on the freehold area A

Finally, we may assume that it was desired to add a new and separate department, say a forge, and that this new department required only cheap iron buildings to house it In this case it was

found impossible either to purchase freehold or even to obtain an adjacent site on a resonably long lease, so that the new extension area C was simply rented at an ordinary yearly rent As this department is entirely distinct in its nature from the remainder of the plant it is considered for factor purposes as a separate area, not to be consolidated with A and B

In setting up land factors for this plant the first step will be to find the unit value of each separate area, afterwards combining the incidence on A and B and treating them as a single area The last extension on rented land C is to be treated independently

Land factor schedule	Totals		Area A		Area B		Area C	
	Invst	Annual	Invst	Annual	Invst	Annual	Invst	Annual
Cap invest	17,500		$15,000		$2,500			
Taxes		$ 76		$ 50		$ 20		$ 6
Interest 6 %		900		900				
Int & amort		140				140		
Ground rent		200				200		
Yearly rent		150						150
Tot annual		$1,466		$950		$360		$156
Areas sq ft	21,200		15,000		5,000		1,200	
Per sq ft cents				6 3		7 2		13

NOTE —Areas A and B = 20 000 sq ft Annual charges = 6½ cts

FIG 58 —Calculation of land factor

Figure 58 exhibits the form of this calculation The first column contains totals of the amounts concerned, while the three next show the distribution over the three areas Taxation is, of course, found in all, interest only in A, since the interest on the capital sum ($2,500) paid for the 50 years lease of B is contained in the next item, amortization, which applies to that area alone Ground rents, which are consequent on the lease, belong to B alone Ordinary annual rent is confined to the small area C A total annual expenditure of $1,466 results in portions of $950, $360 and $156, respectively These latter amounts divided by the square feet in each area give the annual rate per square foot, namely, $0 063, $0 072 and $0 13, respectively Consolidating the areas A and B gives a square-foot rate of $0 065 for these combined areas

We are left, then, with two areas, one of which carries double the land-factor rate of the other, and this may be considered as

representing the actual conditions under which production is being carried on in this plant Should the rented area C be given up, its disappearance would not affect the factor rate of the other area A-B

Bases of Above Calculations 1 *Area A* —The only possible complication in the case of A is in respect of the mortgage It has already been explained that the fact that a certain portion of the purchase of the land has been settled by the giving of a mortgage has nothing to do with production or costs It is a purely financial transaction equivalent to the pledging of any other piece of property on account of money borrowed It might, for instance, be the case that the advance was secured by giving a bill of sale or a chattel mortgage on a number of machine tools No one would venture to assert that this hypothecation of the productive equipment should affect the cost of the work done by this equipment while the debt remained unpaid Anyone would realize that such a transaction was a purely financial matter and that the interest on the debt must be met out of profits The same argument applies with equal force to a debt secured on land or buildings, and, consequently, the capital value of the land to be taken into account in the land factor is its purchase price and that alone The mortgage is ignored In the case of area A, this leaves us with only two items, namely, interest on the capital investment and taxation

2 *Area B* —The tenure of portion B is not freehold but leasehold A payment of $2,500 was made for a 50-year lease, subject to an annual ground rent of $200 In this case we have to provide for three things

a The ground rent of $200 per annum
b Interest on the capital investment of $2,500
c Replacement of one-fiftieth of the capital investment which disappears every year

That this last provision *c* is required will be manifest from the consideration that at the beginning of the lease it was worth $2,500 and could presumably have been resold for that amount, while at the end of the fiftieth year it will be worth nothing at all, the leaseholder's usufruct of the area having expired and a fresh capital payment being necessary if a continuance of occupancy is desired

In practice it is not usual to take the items of interest and depreciation of lease value separately, but to consolidate them

in one amount known as an amortization charge This is done by means of an amortization table which calculates the two items together and resolves them into fifty annual sums of equal amount The principle of amortization may be briefly stated as this Each year a sum larger than the annual interest is set aside, sufficient to replace (at compound interest) the original capital at the end of the given term

The total annual expenditure for area B is therefore made up of ground rent (*a*) and amortization (*b* and *c*) to which must be added the annual taxation incident on the area

3 *Area C*—This area presents the simplest problem of all, as the land is rented at a simple annual rent When to this rent is added the amount of taxation incident on the area, the land factor charges for C are complete

Demolitions—In acquiring a site some preparation of the ground is usually necessary to fit it for manufacturing purposes Leveling has to be done, marshy ground filled in, etc In the case of a site acquired in or near a town or city, it is not infrequently already occupied by buildings or erections of some kind, all of which have to be demolished and carried away before the site can be utilized for the new purpose The question then arises From the viewpoint of the land factor, what is the proper way of regarding this expenditure on demolitions?

Two courses are open First, the cost of preparing the site can be added to the purchase price and so become part of the capital investment on which the land factor will be based Or, second, if the concern be sufficiently solvent, the extra cost incurred may be written off at once to profit and loss

1 *When Included in Capital Investment*—The arguments for this course are based on the consideration that the cost of the site plus the cost of the demolitions is the actual amount of the investment While it is true that what has been done is merely to restore the site to the condition of usable land and, as a matter of valuation, the cleared site is possibly worth no more than it was before the demolished buildings were first placed on it, its present worth is strictly conditioned by the fact that it is now usable Instead of purchasing the land and making its own demolitions, the firm might have rented or leased the site conditionally on the same being first cleared by the lessor In such a case the rent paid for its use would certainly be based on (1) the value of the site and (2) the cost of the clearance For it is

evident from the circumstances of the case that if the demand for that particular piece of land is so urgent that it will pay to clear it, then its ultimate value is a monopoly value, as is not infrequently the case in city sites, of which the constantly rising values are often, in part at least, due to demolitions as new and improved types of structures are in demand

2 *When Written Off at Once* —It must not be forgotten that the effect of adding the cost of demolitions to the capital value of the site will be to increase costs This will be true whether we treat the new site separately or whether it is consolidated with the old areas already in use for manufacturing purposes If the financial condition of the firm is equal to the sacrifice, it might be considered feasible to write off the cost of demolitions out of profits at once, or, alternatively, hold it in a suspense account and write it down out of profits from time to time as opportunity offered Either of these courses keeps the additional expenditure out of costs

Occasional and Recurrent Expenditure —In all cases of this kind, where an alternative exists between so treating an item that it will find its way into costs and so treating it that it is met out of profits, it is better, *provided it is not a recurrent expenditure of any kind,* to write it off either at once or by degrees without letting it enter overhead, that is, any one factor Increasing cost means putting a handicap on competitive power, so that in the end less profits will be made and less available for any purpose, including the writing off in question If an obstacle is met and an expenditure of some amount can clear that obstacle from the normal manufacturing operations, and if then this amount is written off out of profits, the productive forces are put on the same footing as though the obstacle had not existed at all And as it is possible that competitors will have met with no such obstacle, the firm is putting itself back on the same footing as its competitors Under such conditions it would seem advisable to meet the enhanced cost out of profits, if possible

But it is obvious that the expenditure in question must be an accidental or occasional one, that is, one which arises out of an exceptional circumstance and is within option to make or avoid If it were of a kind that is periodic or recurrent, even though at long intervals, it is then doubtful whether it could be legitimately written off, since it would be a part of the regular and foreseen

expenditures which necessarily form part of overhead and have to be taken into account in reckoning the cost of production

Catastrophes —There are cases, however, where large expenditure may be incurred, which obviously cannot be said to add anything to the value of property or to be in any way considered as part of the legitimate cost of production Catastrophes more commonly affect other property than land (*e g* , fires) but land is sometimes subject to one variety of catastrophe, namely, to floods, which may occur at very long intervals and do considerable damage to land surfaces quite apart from damage to buildings or structures on the land itself

The cost of restoring the condition of land which has been subjected to flooding must obviously be met out of profits Production has not been benefited in any way, since when the expenditure has been made conditions are only the same as before and not improved Similarly, the value of the property has neither been increased or diminished, if we assume that the expenditure has simply restored previous conditions It may be taken as a safe rule that all catastrophic expenditures must be written off out of profits either at once or as soon as the financial condition of the concern permits this course They must not be allowed to pass into overhead, that is, to become part of any service factor

Conclusion —We must leave the further consideration of the land factor at this stage since more definite details as to the accounting methods will be dealt with in the next chapter, which will take up the second portion of the land-buildings or space factor, namely, buildings It is more convenient to use one schedule to cover both land and buildings, since, although some land areas have no buildings on them, there are no buildings or erections of any class whatever that do not occupy land areas In accounting for the one class it is very little extra work to account for both The example of a land schedule given above will serve to assist the reader in following the disposition of similar entries when exhibited on a combined land-buildings schedule

CHAPTER XXIII

LAND-BUILDINGS OR SPACE FACTOR

II BUILDINGS

The term "buildings" as used in connection with space factor accounting is employed in a very broad sense It includes not only wood, brick, stone and steel buildings with walls, windows and roofs but also all *erections*, however slight, that may be constructed on a land area for some purpose of manufacturing Nor is it essential that such erections shall be above ground or even in sight Pits, underground tanks, tunnels, wells and drainage trenches must all be included in the definition "buildings" for the present purpose

Difference in Treatment between Land and Buildings—It was shown in the last chapter that, normally, land-factor charges are uniform over all portions of a site, except sometimes in cases where extensions have been made for setting up new varieties of production, such extensions being more costly as regards site value than the original area The uniformity of land-factor charges remains throughout the life of the plant, under ordinary circumstances This is explained by the consideration that the incidence of land charges is beyond control It cannot be reduced by any improvement or change of policy There is nothing individual about the various portions of a level site and, consequently, nothing that can be modified or reorganized A piece of land is a piece of land, that is, it is merely space on the surface of the earth, and it is because it is space and not because it presents a surface of sand, clay or rock that it is usable for the purposes of industry In fact it does not begin to be useful until something is placed on it, that is, until it is occupied Moreover, whatever is done to it, whatever is erected on it, removal of added works leaves it just as before, merely space ready for occupancy, just as good as ever

But when dealing with artificial structures or arrangements, altogether new conditions will be set up While it is true that one square foot of land area is precisely like another, the very oppo-

site is the case when contemplating the variety of erections included in the definition of buildings. Not only is the cost per square foot enormously different but also the moment construction is completed such erections begin to decay, and to decay at rates which vary greatly. Moreover, while land never grows old and out of date, all types of erections have that tendency, so that their useful life is frequently much shorter than their possible physical endurance.

These considerations alone will suffice to lead to the inference that every separate building represents a wholly individual outlay and upkeep, and, therefore, that the accounting, which ultimately is to bring this outlay and upkeep into relation with the cost of processing, must be based on the principle of *isolating the cost and expenditure incurred on each such building or erection and steering it into the appropriate service factor corresponding to the purpose for which the building has been built or the erection constructed.* It is the object of the service-factor method to localize the costs of service from the ground up, and thus gradually build several groups of service cost. This is an entirely different and much more feasible method than would be the attempt to analyze a great array of figures drawn from the records of current working.

Ultimate Aim of Space Factor. Rented Space.—While the consideration of rented space (which may be a simple floor in a loft building or a factory of several shops, power house, etc., within its own fence) will be considered later, it may be desirable to observe at this stage that the aim of a land-buildings factor is to reduce all annual expenditure on buildings to simple rents, such as would be paid to a landlord if the item were rented instead of being the property of the firm engaged in manufacture. It was pointed out in Part I that all rents are composed of elements, some invariable and some based on careful forecast. When rent is paid, it is really paying for a number of elements which, taken together (including of course landlord's profit), make up that rent. A land-buildings factor is simply doing *for the firm's own use* what a landlord necessarily does when he fixes a rent that he is prepared to accept. The landlord may not go into as great detail for the purpose as it is necessary for the firm to do, because he has a margin (profit) to go on, and any error that creeps in, as for instance in annual cost of repairs, is taken up by this buffer amount.

In setting up service factors it is required to ascertain with close accuracy *for each separate building*, the annual expenditure corresponding to landlord's rent, and additionally, in some cases, the cost of lighting and heating, etc, which are not commonly included in rent The inclusion of the latter items in the land-buildings factor is by no means essential They might be made the subject of a separate factor or even included in the power factor In general, however, the definition of "ready for occupancy" seems to mark a convenient stage or boundary and, therefore, such items are included here This, however, is the only respect in which the space factor differs from a landlord's rent if we ignore the question of profit

Elements of Building Factor—Having in view the wide range of erections to be included under the term "buildings," it will be evident that the elements entering into the factor charges for any given set of buildings are likely to vary both in number and amount In general, *the building factor is intended to represent the annual expenditure on the building maintained in full efficiency for the purpose it is supposed to fulfill* Thus, in the case of a processing department, the building factor represents the annual cost of such building, heated, lighted, kept in repair, whitewashed or kalsomined, cleaned and in all other respects ready *for* occupancy But it does not include any expenditure *on* occupancy, such as watchmen, messengers, lavatory supplies, etc

Such a department exhibits the buildings factor at its maximum of development From this maximum we may sometimes have a series of erections each of which becomes simpler and possesses fewer elements of expenditure, until we reach the case of an isolated explosives hut or a pipe trench in which such elements of cost are at a minimum

Land-factor Charge—As all buildings, whether a solid concrete and steel shop, or a flimsy roof over rough storage, or an underground tank occupy land space, it will be evident that the first element of a building factor is in all cases an appropriate portion of the land factor corresponding to the dimensions of the space occupied This, as shown in the previous chapter, may be compounded in various ways, according to the tenure by which the land is held, but in every case is finally represented by an annual charge per square foot of surface occupied A land-factor charge representing the annual cost of the site occupied is, therefore, the first element of a building-factor charge

Capital Investment Charges —While the land-factor charge usually will be the same for all buildings, depending only on their dimensions, the charges depending on the buildings factor are individual That is to say, that even where two buildings represent an identical value of capital investment, it by no means follows that their annual building factor would be identical also

While the items entering into a building factor are not always the same, certain items are practically always present, and among these will be the varieties of charge based on the capital value of the erection These are (1) interest, (2) depreciation, (3) insurance, (4) taxation Before considering these, the nature of the capital investment itself may be worth some examination, particularly in regard to the differences which exist as compared with an investment in land

1 *The Capital Investment Itself* —There is one fundamental difference between value as represented by land and that represented by practically all other kinds of tangible property In popular language the value of a land investment "stays put" A freehold purchase of land does not deteriorate in value, unless in very exceptional circumstances As far as the land itself is concerned, it cannot be said to deteriorate or depreciate naturally, at any rate during use While special circumstances sometimes, and usually temporarily, may depress the value of individual lots of land, it is generally true that land values either remain steady or else tend to rise without any effort on the part of their owners

But this cannot be said of any other tangible property Certainly it cannot be said of any building or other structure as employed in industry Every structure of human origin begins to decay as soon as it is completed And this implies that the values in question are wasting values It is exactly as though a pile of silver dollars slowly evaporated, one by one, until after a longer or shorter period, the space they occupied was empty If a structure is worth $20,000 on the day of its erection, it is worth much less 10 years later, and, in many instances, would be worth nothing at all, or, worse still, in 50 years be regarded as a costly encumbrance to the space it occupies

This wasting value gives rise to numerous complexities in computing charges that are based on the capital investment For, after the first year of service has been completed, the question What is the capital value? is not by any means as simple

as it looks The only thing we can be absolutely sure of is that it is a smaller value than it was on the day of completion [1]

2 *Necessity for Equalizing Charges* —It was pointed out in a former chapter that production is essentially a smooth progression of events and that process work consists in constant repetition of the same movements under the same conditions and, therefore, for equivalent amounts of expenditure If, therefore, any item exists in which the expenditure, though continuous or recurrent, is irregular in its incidence, then measures must be taken to equalize such items so that their incidence is made to run concurrently with working time

At the outset we have encountered an item of very great importance, namely, the capital value of buildings and erections, which is not constant but is subject to reduction from year to year It will be obvious that if, say, 6 per cent interest were to be charged on the capital value the first year and if this capital value had become less the second year, the interest charge would also be less In other words, there would be introduced into the factor a diminishing charge year by year, although the service represented by such charge was being maintained in full use and efficiency This would mean that, in regard to this factor, costs would be diminishing year by year which would be an absurdity and contrary to fact

It is, therefore necessary, to deal with the diminishing value of buildings much as the diminishing values of the 50-years' lease was dealt with in the previous chapter In other words, a mechanism must be set up which will effect these operations

a Interest must be charged each year, not on the original capital value but on the depreciated value

b Depreciation must be charged at such a rate that the annual installments at compound interest will replace the capital value at the end of say, 50 years

c The capital value must be written down, year by year, so that in 50 years the whole is written off

d In giving effect to these requirements the main aim is to charge production *with an equal amount each year* during the whole life of the building On the other hand, it is not of great importance how the capital values are written down, provided that the whole is written down by the end of the fifty years

[1] That is, apart from market valuation A revaluation at the end of the first year might show an increase in value during a period of rising prices

3 *Combined Interest and Depreciation Rate* —The mechanism by which the charges are equalized is known as an amortization rate, the use of which was referred to in the last chapter in connection with the writing down of leasehold values Before discussing this form of rate it may be well to study the way in which values change over a series of years by means of graphic representation in order that a clear picture may be formed of the manner in which amortization works

Figure 59*a* represents the decreasing value of a building of which the life is estimated at 20 years, with a residual or scrap

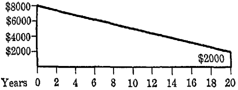


Fig 59*a*

value of 25 per cent of the original cost The day of completion sees the value of the building standing at $8,000, while by the last day of the 20 years this value has fallen to $2,000 This method of depreciation, which leaves a residual value, is not now much in favor, the more common practice being to continue the curve to zero, which gives a somewhat longer life with no residual value

Figure 59*b* represents a case of this kind Here the life of the building is estimated at 50 years with no residual value Consequently, the value which stands at $30,000 on the day of completion falls to zero on the last day of the 50 years Considering how very problematical residual values must be, this latter method is a more convenient and satisfactory one, especially as it makes calculations somewhat simpler

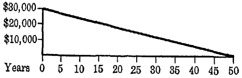


Fig 59*b*

If interest is chargeable year by year on the remaining capital value of that year, it is evident, from the form of the above curves, that every year the amount so chargeable becomes smaller But, on the other hand, there must be something, somewhere, that is getting larger, something that is replacing the diminishing value, and this something is, of course, the amount which is being set aside for replacement by means of a depreciation rate Figure 60 exhibits the shape of this curve, which it

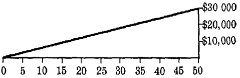


FIG 60

will be observed is the exact complement of the curve of diminishing capital value

The interest curve must necessarily be of the same shape as the curve of capital values, since it is at all times the same percentage of the current value If, therefore, an interest curve and a reversed depreciation curve are fitted together, it is evident that the sum must be somewhere near a constant value, year by year, which is the value required

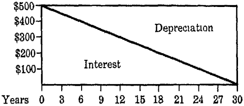


FIG 61

Figure 61 exhibits this arrangement The life of the building is assumed to be 30 years A regular charge of $500 a year is made and this is divided between interest and depreciation in such a way that (1) each year is charged with its proper amount of interest, and (2) by the end of the life period of the building the depreciation fund will amount to the full cost of replacement

The interest is a diminishing and the depreciation an increasing amount, while the total of the two is held *constant* and so is chargeable to production at the same rate year after year.

3 *Insurance and Taxation*.—These items need little or no explanation. An insurance rate and a tax rate are both definite amounts and a very simple calculation suffices to make known what their annual value is for each building on the schedule. While taxation, at any rate, and, in some cases, insurance are variable amounts from year to year, this is in the nature of things and cannot be helped. Taxation is, in general, an item that tends to increase and, therefore, represents a true rising cost of production. Local taxation is subject to spasmodic reductions, at times, but such efforts are usually neither large in effect or permanent in nature. The irregularity thus introduced is not commonly sufficient in amount to cause any embarrassment in comparing the costs of different years.

Repairs and Alterations.—The question of repairs is a difficult one, and, as it is of great importance and applies to all equipment and not only to buildings and is, moreover, mixed with the question of depreciation, it will be dealt with in a special chapter later. But it is desirable to consider here some of the difficulties which beset the problem as they apply to buildings.

Bearing in mind the desirability of reducing all irregular expenditure to a smooth and regular rate of charging to service factors, it will be understood that the very nature of repairs runs counter to this aim. Repairs depend on influences wholly beyond anyone's control. In addition to the slow wear and tear and decay which besets all structures under the most favorable conditions, industrial buildings are subject not only to the usual vicissitudes of storm and tempest, excessive heat and abnormal cold spells but also to stresses and strains due to vibration and to the necessity for changes in the structure to suit new productive methods.

Moreover, as the general tendency of human nature is to put off doing a thing until it is inevitable, expenditure on repairs is commonly made much less uniform than it might be. Instead of closely watching for evidence of weakness or decay and repairing before they get a chance to become sources of further trouble, it is too often the practice to wait until conditions become intolerable, or at any rate very noticeable, before taking them in hand. As a result repairs are apt to take the form of occasional extensive

operations, general overhauls which call for a heavy expenditure over a relatively short period.

Changes and alterations are dictated by the necessities of production and their irregular happening cannot be remedied in any way, since they are not usually foreseeable for any extended period in advance.

In repairs we have, therefore, a class of expenditure that exhibits great fluctuations, not only from month to month but, what is much worse, also from year to year. It is expenditure, moreover, so entirely depending on local circumstances that an attempt to reduce it to something like a depreciation rate is rarely made.

Some Repairs Excluded from Service Factors.—We may, however, make progress by keeping in mind the principle that *all catastrophic expenditure is payable out of profits* and not through costs. If, for example, a shop is unroofed by a whirlwind, or a heavy motor truck runs into and damages a wooden building, or a fire burns down part of the plant, none of the expenditure thereby incurred has anything to do with the regular repairs charge to production. Production is not in the least benefited by any of these catastrophes, and nothing can be included in service factors that does not benefit production in some way. When restoration of the damaged erections has been made, production is only just as well off as it was before the catastrophe—its facilities have not been bettered.

The same argument applies also to changes and alterations carried out on account of some improvement in method, unless such changes have added permanent value to the building. It may, for example, be desirable to install machinery that does not fit in well with the existing spacing of columns. If the latter are of the concrete variety, nothing can be done, but if mill construction or open-steel columns are in use, then it is quite feasible to change the spacing, making suitable provision for bearing the strains and thus accommodating the new machines. But an arrangement of this kind, though quite costly, cannot be said to have increased the value of the structure. It is, as a structure, *performing no more service* than before, regarded as a shelter or working space for productive equipment. The cost of a change of this kind should not, therefore, be charged to capital or to any service factor but directly to profit and loss. To do otherwise would be to handicap the production of the new machines in

comparison with those of a competitor who had installed them in a properly spaced building at the commencement

Repair Items Legitimately Chargeable —If we take the life of a given building at, say, 50 years, it is evident that during this period there will be, exclusive of catastrophes and alterations due to changes in method, a certain sum expended from first to last, which sum has served to maintain the building as an adequate shelter for the work carried on in it If such a sum could be calculated in advance, nothing would be easier than to divide it into fifty parts and charge one such part every year Apart from alterations, expenditure on repairs is likely to increase toward the end of the life of the building, while in the early years but little such expenditure would be incurred Theoretically, with a sufficient area of experience to draw on, it would be possible to make a uniform rate for the whole period which would accumulate the unexpended amounts in the early years and so form a fund for the later years

An arrangement of this kind, while having very close likeness to a depreciation rate, is nevertheless never made It is not perhaps so much the difficulty of fixing adequate repair rates as that the perspective is too long for the average executive To look 50 years ahead demands a certain pressure or necessity that is not usually felt in this connection A repair rate for the life of the building is, therefore, not to be expected at the present time

The next best thing is the establishment of a rate which will hold good for a single year The amount of repairs likely to be required on a given building (omitting alterations and catastrophic expenditures) can easily be forecasted with fair accuracy by one familiar with the history of the buildings and the accounts of past years If it should happen that a periodical overhaul of any particular building is due, giving rise to an abnormal repair expenditure for the year, it can be arranged to carry over a portion of the amount for one, two or three years, according to the importance of the sum in question It is obvious, of course, that this expenditure should have been made and charged into the *previous* years during which the decay occasioning it was taking place, but, in the absence of a repairs rate for the life of the building as suggested above, the present method is the best available

Maintenance Items Other than Repairs —The cost of painting and kalsomining or whitewashing buildings is reducible to an annual charge if not actually annual in fact If done, say, every

three years, then one-third of the expenditure should be charged each year

In regard to cleaning of windows and floors, there is no difficulty in ascertaining the normal expenditure on such items The cost of cleaning windows will bear some relation to the area of glass and that of cleaning floors to the floor area But, as between buildings, the cost of cleaning per square foot will vary greatly according to the nature of the work carried on in the building For this reason cleaning is sometimes considered as belonging to the organization factor and not to the building factor It does not greatly matter where a doubtful item is placed, provided it is always placed in the same factor, and cleaning cost does bear a somewhat close relation to occupancy, *i e*, it comes well within the definition of an item expended to maintain a building "ready for productive or service operations"

Heating —The same objection might be applied to inclusion in the building factor of a charge for heating Occupancy certainly affects this charge Some shops may, for example, utilize heat as part of the processing and so much may escape into the shop that no artificial heat is required in any month Other buildings, such as some kinds of storage houses, may have no heating at all, others may require relatively high temperatures in months when other shops are not using artificial heat, and so on Nevertheless, whenever heat is used, it bears a close relation to the cubic content and, therefore, to the floor area of the shop and is conveniently incorporated in the buildings factor

It is of course understood that the only kind of heating being considered now is that which raises the temperature of the whole building Heat used in any kind of process or service is chargeable to that process or service Steam supplied to a drying room is, for example, purely an item of process cost, but that supplied for the purpose of heating the shop in general is a service cost chargeable in building factor

Items Included in Heating Charge —The items to be included in the heating charge necessarily depend on what type of heating is employed In general, however, it will consist of two divisions

a Items arising within the building or department

b Items coming from outside

In the first division, interest, depreciation, insurance and maintenance of the heating devices and appliances, such as pipes and

radiators installed in the building, will be the principal items, while the cost of steam supplied will be the principal item coming from outside The annual value of these items presents no difficulty of calculation, provided conditions are normal

The chief difficulty in connection with the forecasting of a heating charge is, particularly, in northern regions, the considerable difference between one winter and another in regard to call on heating facilities The impossibility of foretelling the severity of individual winters introduces a fluctuation in the heating charge that is only partly compensated by the fact that, while heating is required only in the winter months, its incidence on service cost is spread over the whole year In a given locality the average cost of heating per annum will usually be calculable, and the deficit or surplus at the end of the year, in respect to heating charges incurred and charged into cost through service factor, should be small The treatment of such deficit or surplus must be left to a later chapter In calculation of heating charge, the chief interested is the *average* cost of heating, taking one year with another

Lighting —Electric illumination in one form or another is now practically universal in manufacturing plants and its accounting presents few difficulties As in the case of heating, we have items arising outside and others inside the building From outside will be derived the cost of current supplied, whether this current comes from public supply mains or from the firm's own power plant To this must be added interest, depreciation, insurance and maintenance on the value of fittings, lamps, wiring and transformers within the building An annual cost for lighting of the given building will then be calculated, based on the number of working hours per annum

Just as in the case of heating, a certain amount of fluctuation is introduced into this item by the uncertainties of climate, particularly in foggy and damp localities In the fall and winter months, dark days or early darkness may cause greater expenditure of current than average Though this fluctuation (as with heating) is to some extent absorbed by being spread over twelve months, it may be sufficient to give rise to a discrepancy at the year-end, more current being chargeable to overhead than has been distributed through service factors The manner of handling this discrepancy will, as with the case of heating, be dealt with in a later chapter

Assembling Elements of Space Factor —In order to set up space factors for each working space and erection, the various items or elements described in the foregoing pages must be assembled in such a way that each unit is chargeable with its own proper proportion of each such element The principal elements entering into space factor may be recapitulated as follows

1 Land factor charge
2 Capital investment on buildings charges
   a Interest
   b Depreciation
   c Insurance
   d Taxation
3 Annual cost of maintaining and repairing building
4 Annual cost of painting and kalsomining
5 Annual cost of cleaning building
6 Annual cost of heating building but not including any steam or heat supplied for processing
7 Annual cost of lighting building, based upon standard annual working hours

Rented Premises —Where premises are rented on an ordinary annual rental, only items 1 and 2 will be replaced by the amount of this annual rent, since the terms on which industrial buildings are rented usually throw the onus of repairs and maintenance on the lessee The precise relation of rent to the above items will naturally depend on the wording of the lease, but no items must be duplicated or omitted If, for example, the tenant has to pay the taxes, then this subdivision of item 2 must appear among the items of space factor

Mapping Areas —In order to ensure that each variety of space has received attention and proper treatment, a scale plan of the entire area occupied by the plant should be prepared On this should be marked the limits of all areas (see last chapter) not entering into space factor accounting, and these areas should be shaded or colored so as to eliminate them from further consideration What remains unshaded will be the portion of the estate that is in use either for service or direct production

The location of all buildings, for whatever purpose they are used, must then be shown on the plan, and by the term "buildings" is implied all erections whether temporary or permanent, whether under or above ground, and, in fact, *all artificial modifications of the original land surface that have been made for a definite*

purpose. If certain areas of land are used in their natural state, as, for example, for lumber storage or for a road or yard, the limits of these areas should also be defined on the plan.

When every particle of the land has thus been accounted for, either as covered by buildings or used as open space for some definite purpose, the area in square feet of each plot must be calculated. This can be done roughly, but with sufficient accuracy if care is taken, by tracing the plan on paper with very small squares. Counting the number of squares and allowing for half and quarter squares on the margins will give fairly accurate results. But with a plant of importance and a carefully surveyed plan of the land and building areas, a planimeter should be used to ascertain the size of all irregular areas. The results will then be accurate and reliable.

Land-buildings or Space Schedule.—The information derived from the survey should then be transferred to the upper part of the space schedule (Fig. 62), each plot being entered with such heading as will serve to identify it.

It will be observed that a column is provided on the space schedule for all buildings and erections and for all open spaces utilized for a definite purpose. In many cases these columns will coincide with a productive or service department but not necessarily so. Where a single-story building is devoted to one purpose, say a machine shop or a transformer house, no further subdivision will, as a rule, be required. But in the case of a building occupying a large area and containing several departments, or consisting of several floors, each floor being a department, subdivision of the charge between such departments on the basis of their relative areas will be necessary. More frequently it will be necessary to consolidate the data of two or more columns, as in collecting scattered items of the power plant, or bringing together several storage areas, which, though physically separate, are all to be regarded as extensions of one column.

When all the items appropriate to each space, erection, or building are filled out and the columns totaled, the annual charges incident on each will have been ascertained. In the case of productive departments, which are represented by a separate column, the annual charge total is divisible by the available, *i.e.*, the utilizable, floor area in square feet, and this results in an annual space charge per square foot. Service spaces, erections and buildings will, as a rule, not require reducing to a square foot

Land Factor	Total		Power plant main bldg		Coal storage		Prod dept A		Prod dept Forge		Storage shed 1		Main stores		Yard 1	
Land area sq ft	2 acres 87 120		10 000		4 000		5 000		2 500		3 600		5 000		10 000	
Capital value	$ 2 613		$ 300		$120		$ 150		$ 75		$ 108		$ 150		$300	
Interest		$ 156		$ 18		$7		$ 9		$ 5		$ 6		$ 9		$ 18
Taxes		84		3		1		1		1		1		1		3
Total land factor		$ 140		$ 21		$8		$ 10		$ 6		$ 7		$ 10		$ 21
Building's Factor																
Building area sq ft	48 000		8 500				4 800		2 500		3 600		4 800			
Capital value	$120 000		$25 500				$12 480		$3 750		$3 600		$14 400			
Int & depen		$ 9 600		$2 040				$1 027		$337		$324		$1 080		
Insurance		200		15				12		3		3		8		
Taxes		700		65				53		6		6		32		
Repairs allwce		2 400		510				248		101		108		288		
Painting etc		600		190				195		20		25		120		
Cleaning		2 500		560				810		150		100		600		100
Heating																
Capital value	1 200						200						300			
Int & depen		118						15						25		
Insurance		12						1						2		
Taxes		20						1						1		
Repairs and m tce		100						10						20		
Steam		300						25						40		
Lighting																
Capital value	1 500		100				180		100		90		200		150	
Int & depen		140		8				15		8		7		16		13
Insurance		15		1				1		1		1		1		1
Taxes		30												1		
Repairs & m tce		200		15				20		20		10		25		20
Current		1 200		20				30		25		15		35		40
Total L-B factor		$18 375		$3 445		$8		$2 473		$677		$606		$2 304		$195

NOTE.—The figures in this example are arbitrary and do not necessarily represent actual or relative values of the various items
Cost of land $13 60 per acre = 3 cts per square foot

FIG 62 —Portion of a space factor schedule

per annum basis, the ascertainment of total annual charge being all that is necessary.

Charges to Other Factors.—Many of the columns will represent service charges and others will represent charges to productive departments, but no actual charging or crediting takes place, inasmuch as the schedules are simply forecasts of certain annual expenditures and not accounts in any sense. Nevertheless, it may be said that all of the columns of the land-buildings schedule (which virtually represent annual rents for buildings and spaces) are made use of to compile other service factors. This is because a building or land area is in itself a perfectly passive thing. While it is contributory to or is a necessary foundation for some service or for production itself, it cannot be said to take any active part in such activity. The *space factor represents the function of the manufacturer as landowner and landlord.* It will be seen, therefore, that all that is done by space-factor charge is the provision of opportunity for operations, and, consequently, the whole of the space factor is absorbable into other factors and reaches cost only in that indirect way. Thus the rents or annual charges for power-house buildings, coal pile, ash dumps, etc., are "charged" to the power factor. The rent of an office building is "charged" to the organization factor. Stores buildings and storage-land areas are similarly "charged" to the stores-transport factor, and so on. The object of the space schedule being to determine rents, other factors occupy the areas and buildings producing those rents, and, when all factors have been calculated, all of the columns of the space schedule will be taken up by other factors.

Available Floor Space.—Where the space charge in a given building has to be distributed over more than one factor, as, for example, part to stores-transport factor on account of passage ways, or conveyor areas, or a substores, part to productive machinery and, possibly, part to unutilized space, it is then advisable to prepare a plan of the floor area in a similar fashion to the plan set up for land-space allotment. If there are several production centers to which individual process rates will eventually be assigned, it will be desirable to show on the plan the location of these centers and the working space around them. In this way the whole floor space will be mapped out into areas of definite extent, and, the square feet in each area being calculated, the annual space charge for each area is known. The

different space charges are then transferred to other service-factor schedules as indicated by the use made of the spaces in question

Revaluations —The values to be set down as capital investment against each item are actual values as expended It is sometimes claimed that values should be reconsidered each year in the light of market prices In a period of increasing prices this would mean that the capital values would be inflated to correspond with what was judged to be the true reproductive value In a period of declining prices the capital value would be written down on the same basis While there is no objection to revaluations of this kind and the setting up of reserves, etc, on the books in accordance with the difference between the true and the supposed values, *such modifications should not be allowed to enter the detailed accounts* Capital value for the purposes of cost accounting should be the value at which the equipment was purchased To tamper with this quite definite figure would very soon lead to an accounting erection built on shifting sand, so that after a few alterations of this kind the precise significance of the figures yielded by the accounts would be exceedingly difficult to determine and still more difficult to compare on any intelligible basis with those of other years

Summary of Space Factor Charges —Figure 62*a* shows the manner in which the figures of the schedule Fig 62 are summarized or recapitulated The totals of the schedule are grouped according to the uses of the areas and buildings

Thus, all the items relating to power generation are summarized for transfer to power factor All the varieties of storage areas and storage buildings are similarly collected to be transferred to the storage-transport factor Office buildings, to be transferred to organization factor, are given next in order, followed by plant engineer's and superintendent's offices which are transferable to the supervision factor The remaining items are the space charges which relate to productive departments A, B, C, D, and they are, of course, kept separate as each is charged individually to the department concerned

When all of these entries have been made, the entire expenditure on land and buildings maintained in a condition ready for occupancy will have been transferred to other factors, since space-factor charges can be accounted for only by considering the uses to which the space has been put, and the cost of these

uses is represented by the other service factors which we shall now proceed to discuss

The item "office and organization" which appears among the allocations may require some explanation The expenditures in this item will generally include the cost of maintaining office space for the selling department Such expenditures have of

Item	Amount
Power plant	$
Main Bldg.	3445
Coal Storage	8
Yard No 4	96
Total Power plant	3549
Stores -	
Shed No 1	606
Shed No 2	720
Yard No 1	195
Main Bldg	2304
Total Stores	3825
Office & Org'n	
Main Office	3174
Equipment	290
Safety	160
Fire	95
Total Office & Org'n	3719
Prod Depts -	
Forge	677
Dept A	2473
Dept B	8162
Total L B Factor	18,375

FIG 62a

course, nothing to do with production and must eventually be subtracted from production expenditure

In practice this is effected at a later stage The space-factor charges incurred by the main or general offices appear in the organization factor (Chap XXVII) and are analyzed into selling and production portions along with other items in the schedule pertaining to that factor

CHAPTER XXIV

THE POWER FACTOR

Having now, as it were, entered into possession of the plant with its buildings, erections, and open land areas available at determined rents, *i e*, at certain definite annual charges per square foot per annum for occupied space, we may proceed to consider the annual cost of the different services which will be housed and operated in these buildings and, to begin with, it will be convenient to select the power factor for discussion, since, in modern manufacturing, the supply of power is antecedent to most other operations

Sphere of Power Factor—The power factor, as has been explained in previous chapters, represents *the function of the manufacturer as furnisher of power* If the plant power equipment is regarded as that of a central station operated by an independent corporation, a very fair idea of the correct method of handling the power-service factor is gained A public service station, however, manufactures power and delivers it by means of mains to the customers' premises, but it does not usually own the interior wiring, motors, transformers and other equipment by which such power is applied as required for the purposes of manufacturing In this latter respect the power factor, then, differs from the sphere of a public service station, because it embraces the manufacture of the power and its delivery at the point of consumption, namely, at the machine or other consuming device and not merely at the door of the shop

A public service station, also, does not usually undertake the supply of anything beyond electric energy The private power station of a plant may, on the contrary, be required to deliver different variety of power

Power-house Accounting—The subject of power-house accounting, especially where power is supplied in several forms, such as live steam, exhaust steam, electric current at possibly more than one voltage, compressed air, hydraulic pressure, etc, is somewhat complex and is outside the scope of this book The

ascertainment of power cost is a wholly different matter from its disposal when ascertained It is this last that is being discussed here

A general idea of the items entering into the *cost of steam* may, however, be useful, *viz*

1 *Space Factor* —Annual space charges on all space occupied by power plant, including boilers, auxiliaries, fuel storage, tanks, softening plant, etc

2 *Capital Investment* —Interest, depreciation, insurance and taxation on all appliances used in connection with steam production

3 *Wages and Salaries* —Share of salaries[1] of chief engineer and assistants Wages of firemen, stokers, fuel and ash handlers, etc

4 *Fuel and Water* —Annual cost of fuel and water used in steam production, including softening chemicals, etc

5 *Sundries* —Annual cost of all waste, oil and minor materials and supplies

6 *Organization Factor* —A small charge may be made to the steam costs for share of general organization This is not obligatory, inasmuch as organization charges are really incurred for productive purposes But under special conditions, where power forms a very large fraction of total expense, it may be fair and proper to do so

[1] Remainder chargeable to the other forms of power produced

FIG 63*a* —Steam cost

Steam Distribution Equipment —In addition to the annual charges arising within the power plant and its accessory buildings and areas, another set of such charges will arise from the fact that steam has to be delivered to various points in the plant, whether for heating or for process work of one kind or other Mains, branch piping, valves and meters are required in this connection and these are subject to depreciation and interest, insurance, taxation and cost of maintenance and repair But it will be obvious that this additional expenditure bears on the cost of only a portion of the steam Steam that is used in the power house for the purpose of electric generation is not to be saddled with the cost of transmitting other steam to distant points

Standardized Cost of Steam —The annual cost of producing steam being thus ascertained and the number of pounds of steam required for all purposes, including processing (if any) during the standard working hours of the year being tabulated, a standard price per pound has been determined for steam delivered to engines and to shops Steam, usually exhaust, will also be supplied for heating the shops, and the price of this will have to

be adjusted For the method of collecting and ascertaining steam cost in detail, one of the special textbooks on this subject should be consulted

Electric Current Production —Items entering into the cost of current will be, in general, as follows

1 *Cost of steam* at standard price per pound

2 *Space Factor* —Annual space charge on engines, generators and other electric equipment

3 *Capital Investment* — Interest, depreciation, insurance and taxes, repairs, etc , on all appliances used to generate electricity

4 *Wages and Salaries* —Share of salaries of chief engineer and assistants Wages of engine attendants, electricians and other employees concerned with current generation

5 *Sundries* — As above

6 *Organization Factor* —As above

FIG 63b —Electricity costs

Current Distribution Equipment —Unlike steam, practically all current generated is distributed to various parts of the plant The cost of this distribution has to be added to that of generation in order to give a figure for current *delivered* Mains and branch transmission lines, meters, switchboards and switches, and similar equipment will be taken into account With regard to motors some difficulty arises in a few cases It may be that a portion of the current is consumed by machines having motors built in or machines served by their own individual motors Another portion may be delivered to large motors driving lines of shafting As a general solution of this problem, it may be sufficient to treat built-in and individual motors as part of the productive equipment of the process, while all motors driving shafting are considered as part of the current distribution system

Capital and maintenance charges are then calculated for the electric distribution equipment as for the steam distribution equipment, so that we have an annual charge for the use of all such equipment

Power Supplied from Public Service Mains —Both electricity and steam may be taken from public service sources instead of being manufactured in the plant, the former almost everywhere and the latter only in certain localities and then chiefly at pressures suitable for heating Whether or not it will pay to take either or both of such services is entirely a matter of local condi-

tions In industries using much steam the advantage of public electricity supply is not as great as where there is no such requirement But where current is taken from public mains it usually implies that steam for heating in winter must be generated at the plant, unless it is located within the area of a public steam service

The accounting is somewhat simplified when electricity is taken from the mains The terms will probably involve a minimum consumption, *i e*, in order to get the advantage of a low rate a certain number of kilowatts must be paid for annually whether actually consumed or not Apart from this the situation is similar to that of the plant's own power station when cost per kilowatt has been determined at the switchboard In both cases the cost of distributing the current and metering it at the points of consumption must be added to the kilowatt rate All the work of computing the cost of the switchboard kilowatt is eliminated when current is taken from the mains

In most cases the cost of steam for heating will have to be substituted for that of a complete power plant where current is taken from the mains This is a simple matter, although on the same lines as the cost of general steam supply As before, the cost of the steam at the boilers must be ascertained and then the costs of transmitting it to the radiators and other heating devices added The form of the accounting will be the same but with fewer items

Power Factor Charges—If it is kept in mind that power generation and distribution are to be regarded as a separate business, and that power costs are to be billed to departments precisely as though the power consumed were coming from an outside source, then no difficulty will be felt as to the making of power charges On the one hand we have a scheduled total *consumption* for the standard working hours of the year On the other the budgeted *cost* of the power consumption thus scheduled In effect this is making a contract to deliver standard quantity of power through standard hours It is this scheduled amount of power at budgeted or standard cost that is charged to each department month by month If production is 100 per cent of standard, then power consumed should agree with power as scheduled If budgeting is 100 per cent correct, then power as charged should agree with actual cost of power

If, however, production is less than 100 per cent of standard, then inefficiency sets in Less power will be required, but this

smaller amount of power will probably not cost less than the standard quantity, unless in cases where production is deliberately curtailed The discrepancy between power as billed to the shop and power charges as distributed through process rates will then be waste, and, as such, will remain in burden account and eventually be charged off to profit and loss

When production is deliberately curtailed, less power will be generated, but the cost *per unit* of steam or kilowatt of current will be higher than under full time Billing to shops will, therefore, be somewhat less in *total* than normal, but that portion of the charge due to the higher rate will automatically fall into waste and be charged off as superfluous service due to inefficient conditions which are unavoidable

CHAPTER XXV

THE STORAGE-TRANSPORT FACTOR

While the two service factors hitherto considered, namely, the space and power factors, are easily recognizable as exactly equivalent to rents for land and premises and as bills for power supply, respectively, the remaining factors have no corresponding commercial parallels. The idea that shops and premises can be rented on an annual tenancy which includes lighting, heating and cleaning demands no special tax on the imagination. Similarly, the idea that a bill for steam or current supplied to a productive department from the firm's own power plant is exactly equivalent to a similar bill received from a public service station is obvious enough.

In each of these cases it can be seen that the service factor corresponds exactly to a function exercised by the manufacturer that is entirely separate and distinct from his prime function, namely, production of goods. Whether or not he elects to exercise these functions, or either of them, is quite optional. He need not own his manufacturing premises and he need not undertake to supply his own power. He can rent the one and purchase the other. In fact, it is frequently done. But if he does elect to exercise one or both of these functions, then the cost of the services so provided should be rigorously kept separate and distinct from the costs of production, and this is effectually done by segregating them as space factor and power factor, respectively.

Basis of Service Factor Application.—There is also another peculiarity attached to the space and power factors that is missing from those remaining to be described. The form in which the cost of service is obtained when the foregoing service factors have been compiled is simple, obvious and familiar. Space factor is expressed in an annual rent per square foot of space occupied. Power factor is expressed as a price, *viz.*, in cents per pound of steam or kilowatt of current supplied. There are no alternatives to these forms, and if a given machine occupies

100 sq ft of floor space and consumes 1 kw per hour of current, there is no escape from the proposition that part of the cost of that process must be made up of just those charges

But when we come to consider the remaining factors there is no familiar and ready-made basis like the square foot and the kilowatt by which service cost can be connected with production cost While it is true that each of the remaining factors is a natural and distinct group of activities, just as separate in its nature from other activities as space factor is from power factor, and while it is just as easy to collect the items of such group and express them as an annual standardized total, *the basis on which the factor change can be billed to production* is necessarily unfamiliar and to a considerable extent arbitrary This is not to say that it cannot be satisfactorily accomplished, but only that careful judgment is necessary, since there is no ready-made basis to go upon

The Storage-transport Factor *Definition of Scope*—In all plants material and the movement of material necessarily play an important part, although the degree of this importance varies considerably according to the nature of the industry In some cases product is small, light and compact, demanding no special appliances for its movement or for handling it at the machines or during processing In other cases it may be in large, heavy and cumbersome units which tax the resources of the expert to handle with the minimum of expense In other cases, again, product may be fluid, and throughout all or part of its career may be pumped and piped Or it may be of such nature that it can be handled in continuous conveyors and passed from process to process almost automatically It is evident, therefore, that a factor aiming to ascertain the cost of all of these varieties of activity must be carefully worked out

The storage-transport factor is so called because it embraces both materials in the quiescent stage (that is, while they are in storage awaiting processing and awaiting their turn between processing) and also all *movements* of materials of whatever nature, provided they are materials *used in production*, or, in other words, materials in course of manufacture

Limited to Direct Material—The distinction involved must be made clear As service factors are services to *production*, it is evident that the present factor must be for services to materials used in salable goods alone It does *not*, for example, include the

handlıng and transportıng of fuel, oı the conveyıng or dumpıng of ashes and clınkeı, all of whıch operatıons are alıeady covered by the poweı factor Noı has ıt to do wıth the movement of fınıshed goods, except ın theıı brıef passage from the last pıocess ın the serıes ınto the fınıshed goods warehouse But every expendıture pertaınıng to the storage and handlıng of materıals used ın manufacture, that ıs, of "dırect" materıals, ıs to be ıncluded ın the stoıage-transport factor schedule

Dıstınct Group of Actıvıtıes —A brıef mental survey of manufacturıng operatıons ın general wıll serve to show that the storage-transport factoı has a clearly defined area of operatıons whıch cannot easıly be confused wıth those of any other factor Whıle ıt does not ınclude any part of the cost *prıce* of dırect materıal, ıt does embrace every expendıtuıe that thıs materıal ıncurs from the moment of ıts entry ınto the plant, ıncludıng the care and surveıllance of ıt ın store houses, the cost of ıssuıng ıt ın requıred lots or quantıtıes, the transportatıon of ıt to the first process and between all subsequent processes and, finally, to the warehouse of fınıshed product In other woıds, the cost of all storage and of all carıyıng to and fıom of *dırect materıal* ıs ıncluded, and nothıng else It ıs a servıce factor ın whıch there ıs, very often, enormous waste and gıeat opportunıtıes for economy When thus segregated and set apart for consıderatıon, a very ımportant class of expendıture wıll be subjected to expert scrutıny Quıte probably thıs wıll result ın the problem's beıng seen as a connected whole for the first tıme

Basıs of Connectıon wıth Cost Not That of Value —Whatever basıs may be selected for establıshıng the connectıon of storage-transport factor charges and unıts of productıon, the *value* of the materıal ınvolved ıs probably the very worst In fact, ın some ındustrıes, the materıal beıng worked on ıs not the property of the firm doıng the processıng on ıt, and ıts precıse value ıs not even known Apart from thıs theıe ıs lıttle relatıon ın most cases between value and cost of storıng and handlıng An ounce of gold ıs worth as much as a ton of ıron, but ıt costs a good deal more to take care of a ton of ıron ın stores and to transport ıt from one process to another than ıt would to handle fifty ounces of gold The storage and handlıng of a gun-metal castıng costs no more than that of one of the commonest and cheapest ıron A part-fınıshed cylınder costs no more to handle than the orıgınal rough castıng

Castings or any other material are not moved about for amusement *Every movement has some relation to a process to be, or which just has been, performed on it* It will, therefore, in general bear some relation to the size, value and importance of the *machine* (production center) by which the processing was effected Again, a large overhead traveler is not put in motion to supply a bundle of metal rods to a group of screw machines, neither is the cost and maintenance of a band conveyor receiving and transferring the product of such machines in any way related to the work of heavy planing and milling machines which are served by the traveler

The solution of a basis for assessment of a storage-transport factor charge is outlined by these considerations It will be seen to have certain natural lines of development, but at present no more need be said than to indicate that the rather obvious basis of value of materials is one which is not suitable It may be said indeed that the not infrequent practice of adding a percentage on value of materials to cover the cost of storekeeping is apt to give inaccurate and sometimes even ludicrous results when there is a considerable range in the unit value of the materials so treated It becomes still more inaccurate when the cost of transportation about the plant is taken into account Transport is a more or less repeated operation, and the ultimate cost of transport of a ton of product depends not only on its weight but also on the number of times that it has been necessary to handle it and the distances it has been conveyed

The Transport Portion of the Factor —The collection of storage charges and their incidence on production is a comparatively simple matter compared with the settlement of costs of transport when the latter is a fully developed service For the present we may confine our attention to a plant having its processes in single departments, that is, where each process forms a department by itself (*cf* Chap XVIII, single process departments), leaving the question of departments containing independent production centers (plural-type departments) till later

If we have a connecting line of transport (which may take the form of a service of electric tractors, or a mechanical conveyor of the band spiral or overhead types, or an industrial railway or even a service of hand trucks), and this line connects two departments, the first question that arises is whether the costs of the service are to be charged to either of the departments separately or

divided between them, as the method of charging on a tonnage or similar basis to the product itself is not considered desirable

1 *Rigid Transport*—The first case to be considered is when two departments, A and B are connected by a line of transport and all product emanating from A passes along this line and is always delivered to B It is also assumed that B receives product from no other source Is the cost of this transport to be considered as borne by process A or process B, or should it be divided between them?

As far as the ultimate result is concerned, it is obvious that each of these three methods has the same effect, namely, that all the cost of transporting between A and B will be borne by all the product passing between those two points But from the aspect of process cost, a difference might be set up if this particular link of the transport system were either more or less costly than the others which respectively feed into A and take product away from B

In a given plant, therefore, it is well to set up a rule, namely, that *either* costs of *delivery* or costs of *collection* should be borne by each process, since the plan of dividing the cost between departments complicates the accounts without effecting any particular solution of the problem Of the two remaining methods, that which charges the process with the cost of collection appears to offer the balance of advantages In this case, just as the cost of manufacturing goods is considered to end at the plant door, so the cost of any one process is considered to end at the delivery point of the machine On the other hand, the cost of collecting material on which to work is considered as part of the cost of the process and enters into its process rate

This may be taken as a good working rule, unless there is something exceptional in local conditions that makes the alternative method preferable

2 *Flexible Transport*—The next case is one in which there are three departments A, B and C, the product of A going in part to B and the remainder to C, which latter department, we may assume, also receives material from other sources, say direct from stores It also may be supposed that the line A-B carries two-thirds of the total movement out of A, and the line A-C one-third The mode of transport may be taken as a service of electric tractors which, starting from A can run either to B or to C as required

If the rule given in the last paragraph is applied here, the problem presents no special difficulties. Department B will take up the cost of two-thirds and Dept. C one-third of the cost of the traffic emanating from A and will charge this amount into cost through process rate. But C will also have to charge the additional cost of its other service, namely, that which runs from stores to C. The transport factor of C will, therefore, have two elements, namely, A-C and stores-C, and the cost of these services will go into its cost through its process rate.

3. *Common Transport.*—We now come to that type of transport which is conducted very much on the principle of a railroad, with terminals and intermediate stations, at any of which product may be either taken up or set down. In general, however, a department will either discharge into or receive from such types of conveyor and not both together. The first step will be to ascertain the cost of the entire system of transport in question, and then study the share of the facilities which each productive department enjoys.

The same rule as to charging cost of the transport to the department receiving the material will apply here. The calculations will be based on standard working hours and, consequently, on standard output of each department, the cost of transport being also reckoned under these conditions. Then, if there are six stations on the line of conveyor, each receiving a portion of the material, the annual cost of the transport system will be divided between them in proportion to the weight of materials or number of packages each receives, when processes are working 100 per cent of their maximum capacity.

4. *Engineering Plant Type.*—In very large plants, mostly of the engineering type, there may be found a regular system of outdoor railroad (which may be of standard gage or smaller) with several locomotives, trucks, cranes, etc., serving to move material from storage or to receive it from the railroad spur and deliver it to shops. It will also move heavy castings, shafts, cylinders, etc., from one shop to another, the tracks for this purpose entering or passing through the shops. This type of transport gives rise to problems of considerable difficulty, not from the transport point of view but because such types are usually found in connection with a class of business in which considerable fluctuation exists. Heavy engineering is to a great extent a "custom" business, that is, its products are made to order, and, therefore, its activities

will depend upon the accumulation of orders to a much greater extent than with a manufacturing concern which can plan, with considerable confidence, for a given output of its product While the determination of transport factors under these conditions is a complex problem, it is solved by application of the same general principles which will be discussed in the following pages

Storage Transport as a Service Department —It will be obvious from what has been said in the foregoing paragraphs that the storage and transport of direct materials is as distinct a service as the furnishing of power or as the provision of buildings ready for occupancy And as the supply of power is usually regarded as the work of a department (*i e*, a service department) so it is equally proper to regard the storage and transport of material as a separate service department The "stores" is indeed usually so regarded, inasmuch as its operations are somewhat like those of a bank, being responsible for the receipt and issue of goods instead of money But storage and transport are really *halves of the same problem*, and while it is proper to ascertain storage *cost* separately from that of transport, there is no reason why they should be consolidated when it comes to considering their *distribution* to cost of production It would, of course, be quite feasible to have two factors, one a storage factor and the other a transport factor, but, as the basis of distribution is obviously the same for each, some advantage is gained by consolidation Moreover, the collection of the figures corresponding to this distinct service into one group enables the relation of the said service to the total production to be seen as a whole, disentangled from all other expenditures

When the whole cost of a storage-transport department has been assembled, a ratio can be set up, by way of a secondary cost, between the total of such service and the total output of the plant, which, being continued from month to month for a series of years, will afford an interesting sidelight on the operation of the service

General View of Factor Relations —Figure 64 exhibits in diagram form some of the relations between cost of storage and transport and departmental process cost Four departments are assumed, namely a forge, foundry, a single-process department, A, and a plural-type department, B, with four production centers 1, 2, 3 and 4

Storage charges come under two heads, namely, those of a general nature, including the upkeep of the main stores department, and those of a special nature, i e , clearly connected with one productive department The billet yard and the scrap and pig stores are of this class, being connected with the forge and foundry, respectively They are, therefore, charged to those departments alone

Transport charges are also of two principal kinds, those which are interdepartmental and represent services of transport between departments, and those which are localized in a department and serve to distribute and removal material from individual production centers As shown on the diagram (Fig 64) these latter are

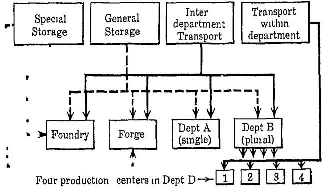


Fig 64

charged directly to the individual centers concerned Interdepartmental transport is charged against departments on the principle described in a previous paragraph

Layout Plan of Transport System —The first step in setting up a transport factor should be the accurate plotting of the layout on a scale plan of the plant Figure 65 presents a rough example of such a plan Transport services are represented by dotted lines, but in an actual plan each service would be shown in a different colored line and the breadth of this line should represent the tonnage or other relative capacity of the service

Services 1 *and* 2 (Fig 65) are tractor services from scrap and pig yard to foundry and from billet yard to forge, respectively Service 7 is also a tractor service, and all three of these services are based on the charging station and tractor garage shown at extreme left of the figure

Services 3, 4 *and* 5 represent an overhead monorail system, the main line of which extends from the foundry to Dept B and maintains service between those two departments A switch enables traffic to leave the main line and be delivered at the point 3, thus connecting foundry and Dept A Another switch enables traffic originating at the point 5 on the spur track to join the main line and be delivered at Dept B This system, therefore, gives services from

Foundry to Dept A (upper spur)

Foundry to Dept B (main line)

Dept A to Dept B (lower spur)

Service 6 is an apron conveyor carrying traffic from forge to Dept B This system has no other outlet and its service is confined to these two departments

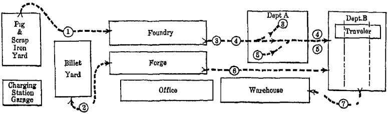


FIG 65

Service 7 has already been mentioned as part of the tractor system It takes finished goods from Dept B and delivers into warehouse

Service 8 is represented by an overhead traveler running over the four production centers which make up Dept B It is, therefore, wholly confined to this department (*cf* the diagram Fig 64)

Having plotted these service systems and routes and having thus secured a clear idea of the details of the transport problem, the ground is cleared for the setting up of schedules in which annual values will be affixed to all of the items of storage and transport service

Scheduling the Storage-transport Charges —The assembly of the storage-transport factor will usually be effected in three stages First, it will be necessary to list the various storage buildings and land areas carrying productive material together with their equipment and the labor, if any, engaged in them

An annual total of storage cost will thus be obtained or *collected*, but its allocation to productive departments must be left till later

Having assembled storage costs, the next step is to do the same for transport costs Another schedule is prepared for this work in which each transport service is listed with all the items that go to enable it to function By this schedule we *collect* the annual charges for each separate service, and the allocation of these charges to productive departments is left to the next step

Both the collected storage and the collected transport charges are now assembled in a final schedule which lists the different productive departments Storage and transport charges taken from the two previous schedules are then finally allocated or distributed among the actual productive departments in proportion as each makes use of or enjoys the benefit of such services These three schedules will now be described and illustrated

Storage-factor Collection Schedule—Figure 66 shows the form which this schedule will usually take Only a portion of

Item	Total		Main Storage		Shed C		Scrap & Pig Storage		Billet Yard		Shed D	
Space Factor		$		$		$		$		$		$
Capital Investment	$											
Store Fixtures	$		$									
Weighbridges	$		$				$					
Magnetic Crane	$						$					
Overhead Traveler	$								$			
Counting Mach,	$		$									
Office Equip	$		$									
Interest & Dep		$		$				$		$		
Insurance		$		$				$		$		
Taxes		$		$				$		$		
Repairs & Mtce.		$		$				$		$		
Salaries		$		$								
Wages		$		$				$		$		
Power Current		$								$		
Minor Supplies		$		$				$		$		
Interest on Stores		$		$		$		$		$		$
Totals	$	$	$	$		$	$	$	$	$		$

Fig 66

the schedule is shown, it being assumed that other storage areas and buildings exist, not included here The principal items common to most plants will be briefly explained, it being understood that other items may sometimes be present, but the general treatment will be sufficiently plain to enable variations to be dealt with

In Fig 66 each heading has two money columns Items pertaining to capital investment are placed in the left-hand column and items of annual expenditure in the right-hand columns Wherever the dollar sign appears, entries will appear Where no sign is shown, it implies that the items on the left are not represented Thus, the item "counting machine" appears under capital investments A dollar sign is given, first, in the Total column and, second, in the Main storage column In both cases it appears in the Capital investment column only This value appears in the Main storage column only because it is there located and there is no other counting machine anywhere else It appears in the capital investment columns alone because the interest and depreciation, etc , charges on it are consolidated with the other equipment and, therefore, no annual charges are shown separately for this item

Similarly "power current" is shown only in Total column and as chargeable to billet yard This current is for the electric overhead traveler in the billet yard and no other storage building or area uses power current Both in Total column and in Billet yard column it appears, of course, on the right or annual charges side It may be desirable to remind the reader that only power current is dealt with here Lighting current is included here in the space factor as described in Chap XXIII

The items making up the storage-factor charges may now be briefly enumerated and discussed

1 *Space-factor Charge*—Certain of the space-factor charges will be for land areas only, as in the case of the scrap and pig storage which we may assume to be piled in the open air Others will be land-buildings space factors, that is, the charge will be made up of a land factor for the use of the land on which the erection stands and a buildings factor for the use of the erection, heated, lighted and ready for occupancy Of course, some of the erections will not be heated, though probably all of them will be lighted, and this may apply also to the simple land areas The scheduling of space-factor charges has already been detailed (Chaps XXII, XXIII)

2 *Capital Investment*—Under this head are listed all of the different classes of equipment used in connection with storage work The items are self-explanatory, but some explanation as to the reason for including the magnetic crane in the scrap and pig yard and the overhead traveler in the billet yard may be desirable

These items are included here because these mechanisms are purely internal affairs of the storage department which is itself a service Although performing transport work, this transport is entirely within the stores and is, therefore, on a precisely similar footing to stores labor, supposing that instead of using a crane or traveler the materials were loaded by laborers onto the skids which collect it for use in the foundry and forge The case is also precisely similar to that of a conveyor used for handling coal for the power plant or ashes from the boilers In each such case the mechanism in question is *performing a service for a service factor* and not directly to a productive department Its cost and upkeep is, therefore, properly charged to the factor for which the service is being performed, namely, in this case, the storage factor

3 *Interest and Depreciation* —This entry is a summary of the individual depreciation charges which go against each separate class of equipment The depreciation charge is combined with the interest charge on the amortization principle, as explained in a previous chapter The entries opposite this item are merely the resulting total of all such charges for one year

4 *Insurance, Taxes* —These items refer, of course, only to the values contained in this schedule and enumerated under "capital investment"

5 *Repairs and Maintenance* —This caption includes all repair and upkeep of items listed under "capital investment"

6 *Salaries, Wages* —Salary of the chief storekeeper and wages of his assistants—inventory men, laborers, clerks etc —are comprised in these items Most of these will be in the main stores, but it is assumed that a man is employed in the scrap and pig yard and another in the billet yard, which explains the dollar sign in those columns

7 *Power Current* —The magnetic crane in scrap and pig yard and the overhead traveler in billet yard use power current and dollar signs accordingly appear in these columns The cost of current for lighting is included in space factor

8 *Minor Supplies* —This item is self-explanatory It includes lubricating oil for the equipment and other small matters

9 *Interest on Stores* —This charge represents interest on the *average* monthly balance of stores in hand in each storage place When a similar value of stores is carried at all times, no difficulty exists in relation to the calculation of interest, since the average

value will coincide closely with the actual value on any one month's balances But where the business is seasonal and much heavier stocks are carried during one part of the year, the annual sum of such balances should be worked out by aggregating the balances of the individual months and averaging

10 *Totals* —Having filled out the entries as above described, the columns are then totalled up These totals will represent the annual cost of keeping stores in the various locations, and this annual cost will be dealt with in the storage-transport distribution schedule to be described presently

Transport-factor Collection Schedule —This schedule (Fig 67) collects transport charges in the same manner as Fig 66 collects storage charges In this case, instead of collecting items by locations, they are collected by services The object is to ascertain the standard annual cost of each separate transport service or group of services, leaving the question of the allocation of such charges till later The items on this schedule are briefly enumerated and explained as follows

1 *Space-factor Charge* —Space factor is only incurred by transport systems when they occupy floor space or land areas Overhead travelers, telphers and overhead monorail systems, except in so far as they obstruct and prevent the use of space, do not incur space-factor charges Where space is used for transport purposes, then, naturally, the transport system using such space is legitimately chargeable with the annual rent or space-factor charge for it

In the schedule (Fig 67) space factor is charged to the tractor system, since it makes use of roadways outside the shops and alleyways inside The space represented by these ways is charged to the factor Similarly, the apron conveyor system (6) occupies land space in passing from forge to Dept B and is assumed not to occupy any floor space within these departments On the other hand, the monorail conveyor system (3, 4 and 5) is assumed not to obstruct or make use of any floor space within the departments served, nor any land space in crossing from A to B The tractor services (1, 2, and 7) are also chargeable with a land-buildings factor for the space and building used as a charging station and tractor garage

2 *Capital Investment* —These items are self-explanatory The dollar sign opposite each item appears only in the column

representing the service using the equipment and in the total column

3 *Capital Investment Charges*—Interest and depreciation are treated exactly as described above for corresponding items in the storage factor Insurance and taxes also

Item	Total		Tractor lines 1 2 7		Apron convey r 6		O head travlr dept B		Tractor garage etc		Mono-rail lines 3 4 5	
Space Factor		$		$		$				$		
Cap Invst												
Monorail track	$										$	
cage	$										$	
motor	$										$	
carriers	$										$	
Tractor units	$		$									
batt	$		$									
spaces	$		$									
skids	$		$									
Apron eqpt	$				$							
Traveler	$						$					
motor	$						$					
gantry	$						$					
Garage eqpt	$								$			
swbd	$								$			
Annual Charge												
Int & depen		$		$		$		$		$		$
Insurance		$		$		$		$		$		$
Taxes		$		$		$		$		$		$
Repairs, etc		$		$		$		$		$		$
Foreman s wages		$		$				$		$		$
Operator s wages		$		$				$		$		$
Power current		$				$		$		$		$
Minor supplies		$		$		$		$		$		$
Tol ann charges	$	$	$	$	$	$	$	$	$	$	$	$

FIG 67—Transport factor collection schedule

4 *Repairs and Maintenance*—This charge represents annual cost of repairs and maintenance for each of the items of capital investment scheduled, exactly as in the case of storage equipment

5 *Wages*—The wages of all transport men operating services are given here In the case of the foreman of transport, where one is employed, his wages will be prorated among the different

services according to the amount of attention he is considered to give to each

6 *Cost of Current* —Cost of electricity to operate the various equipment is the only source of the entries under this item The cost of charging the tractor batteries will go against that service, and current for the monorail and conveyor systems as used annually by those services

7 *Total Annual Charges* —When all the columns have been filled out and totaled, the totals collected are the annual costs of maintaining each separate group of services, namely, tractor, monorail, conveyor and traveler These annual costs will now have to be allocated to the different departments enjoying the services, and this final operation is effected by the schedule now to be described

Storage-transport Distribution Schedule —Figure 68 represents the method by which the annual charges for storage service and transport service which have been collected on the two previous schedules are allocated or distributed to departments, and where a department is of the plural type (*cf* Chap XVIII) it may also include distribution to the individual production centers within such department If, however, these are numerous, it will be better to distribute herein to the department only and effect the distribution to individual centers by a special schedule for such department or departments

1 *Storage Items* —The items shown under the main grouping of "annual storage charges" will be the same as the titles of columns on the storage collection schedule (Fig 66) The footings of those columns appear here opposite each storage item in the Total column The allocation columns are headed with the names of productive departments and it is the office of this schedule to divide the cost of each storage location between the departments enjoying each service

2 *General and Special Items* —It will be noticed that the first four items are not allocated but merely accumulated in a total called "total general storage" This is because the materials located in these buildings are similar to those in the main stores, *i e*, they are not deliverable to any one department For this reason they are grouped with the main stores and the total for the group distributed among all the departments The basis of this distribution will be in proportion to the average weight of material delivered during the year to each department

The remaining storage items, namely, "scrap and pig storage" and "billet storage" have nothing to do either with each other or with departments in general. The former is wholly confined to the service of the foundry and the latter to the service of the forge. The annual costs of these two storage locations are, therefore, charged directly to the foundry and forge, respectively, as shown by the dollar signs.

Storage-transport factor Distribution of Charges	Annual total	Foundry	Forge	Dept A	Dept B Production centers				Finished goods warehouse
					1	2	3	4	
Annual Storage Charges									
Main stores	$								
Shed C	$								
Shed D	$								
Etc	$								
Total General Charge	$	$	$	$	$	$	$	$	
Scrap & pig storage	$	$							
Billet storage	$		$						
Total all storage	$	$	$	$	$	$	$	$	
Annual Transport Charges									
Monorail service	$			$	$	$	$	$	
Tractor service	$	$	$						$
Apron conveyor	$				$	$	$	$	
Overhead traveler	$				$	$	$	$	
Charging room	$	$	$						$
Total transport	$	$	$	$	$	$	$	$	$
Gd tot storage & transport	$	$	$	$	$	$	$	$	$

FIG 68.—Distribution of annual storage—transport factor charges to processes (i e to departments and production centers)

The item "total of all storage" merely serves to recapitulate and check the correct allocation of all the above items to their respective columns and to enable comparison of grand total to be made with that of the collection schedule (Fig 66).

3 *Annual Transport Charges*.—The items appearing in the Total column of this schedule will be the same as those of the footings of the transport collection schedule (Fig 67). Each service is treated on a separate line, and the purpose of this schedule is to allocate the annual cost of each such service to the department enjoying it, that is, as above explained, on the basis

of the relative amount of material *received* by each department sharing a common service

4 *Monorail Service* —Reference to the plan (Fig 65) shows that this service has two collection and two delivery points Traffic coming from the foundry may go straight through to Dept B or it may switch off and be delivered at the top of Dept A A spur collects traffic at the foot of Dept A and delivers it at B

In allocating the charges all we have to consider is what is *received* by A and what by B Although it is true that the length of haul from foundry to B is greater than in the other two cases, this may be generally ignored unless the difference in distance is important In this case no substantial injustice will be done by ignoring the difference of haul and considering merely the weight of material transferred

As the plan shows, in this particular case, *all* the product emanating from foundry eventually reaches B, because that delivered in A is obviously picked up again and delivered to B, as A has no other traffic inlet or outlet than the monorail system But it does not, therefore, follow that the weights traveling from foundary to B are the same as from A to B Only a minor portion of the product might be processed in A, the main portion going straight through to B If we charge Dept A with the tonnage it receives, therefore, and Dept B with the tonnage it receives, all the traffic will be accounted for on a fair basis

5 *Example of Allocation of Transport Charge* —To make this point clearer (as it is one which will occur frequently in deciding the allocation of transport services), the movements on the monorail service may be illustrated by Fig 69 It will be seen from this diagram that 12,000 tons go from foundry to Dept B, 6,000 tons from foundry to Dept A and 6,000 from A to B, making a total movement of 24,000 tons handled If it is assumed that the total cost of the monorail service is $1,920 per annum, this amounts to 8 cts per ton handled

The diagram shows that the movement of traffic is distributed thus

Dept A receives 6,000 tons from foundry @ 8 cts		$ 480
Dept B receives 6,000 tons from Dept A @ 8 cts	$ 480	
Dept B receives 12,000 tons from foundry @ 8 cts	960	
Total for B	$1,440	1,440
Total monorail		$1,920

If the distribution of traffic emanating from foundry were the same in tonnage but different in destination, being 16,000 delivered tons to Dept B and only 2,000 to Dept A, then there would be a lessened *total* of tonnage, because, while 18,000 tons leaves foundry as before and also arrives as before in B, the amount *rehandled* on the A-B line will be only 2,000 tons, making a grand total tonnage of 18,000 + 2,000, or 20,000 tons, instead of 24,000 as before If under these conditions the same cost of the service, namely, $1,920, were maintained, then the tonnage rate would be higher

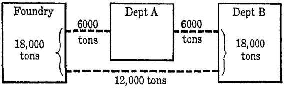


Fig 69

6 *Rule for a Mixed Service*—A working rule for distributing the cost of a service delivering to more than one department may be stated as follows

a Ascertain the total annual cost of the service

b Ascertain the annual amount (tonnage) *received* by each department

c Distribute the cost of the service in proportion to tonnage so received

7 *Tractor Service*—Returning to the distributing schedule (Fig 68), the next item refers to the tractor service which includes routes 1, 2 and 7 The tractor service (which will include the annual cost of the charging station in addition to actual transport work) can be treated exactly as the monorail service The tonnage received by the three points of delivery, namely, into forge, foundry and warehouse, will be the basis for dividing up the total annual cost of the tractor service

Normally this is all that is necessary, but, in a few cases, there might be a considerable difference in the distances covered by the different routes Under these conditions something equivalent to the ton-mile used by the railroads would have to be introduced, such as a ton-100 ft There is, unfortunately, no common unit of length between the rod of 5½ yd , which is too short, and the

furlong of 220 yd , which is too long, for use as a unit in plant transport The way in which such a device would be used in allocation is perhaps sufficiently obvious not to need discussion

8 *Apron Conveyor* —As this conveyor delivers only at one point, namely, into Dept B, the whole of its annual cost is chargeable against that department

9 *Overhead Traveler* —We have exhausted all the *interdepartmental* transport systems and have now to consider a new variety, namely, the overhead traveler situated in Dept B This system does not receive or deliver beyond the limits of the department, and its annual cost is, therefore, chargeable in the first place to Dept B If Dept B were a single or a parallel process department, nothing further would be necessary, but, in this case, the department is a plural-type department (*cf* Chap XVIII) containing four separate production centers Naturally, if the system serves all four of these centers, its annual cost must be prorated between them

If all the four receive about equal service, then simple division by four will suffice for the allocation In the case of a small department like this it is hardly likely that any other arrangement would be wanted It is necessary, however, to point out that, being described as a plural-type department, the implication is made that each center is independent In other words, the stream of material does *not* flow regularly from one to another, for, if it did, then this would not be a plural-type but a single-series-type department, and no individual costing within it would be required It is assumed, therefore, that each center has its own individual call on material and on overhead service, but that taking one thing with another such call is equal for all of them

If it were otherwise and some centers made much more use of the overhead service than others (which would almost certainly be the case in a large shop containing perhaps 50 or 60 machines instead of only 4), then the same principle as already adopted for distributing monorail costs would be adopted to meet this case The tonnage call of each center would be reckoned, and total annual cost of the service allotted accordingly

In a large engineering shop, travelers are commonly erected in "bays" The service of each traveler is thus confined to the machines situated in the bay beneath it This affords a simple solution of the allocation of such traveler services

10 *Total Transport Charges* —This line serves to assemble the costs of transport service as charged to each department separately from that of storage charges

11 *Final Figures of Storage-transport Factor* —In line 11 (grand total of storage-transport factor) are the final results of all the foregoing work If storage and transport are considered as the work of a single and separate department, just as the power plant is a single and separate department, then the figures in columns under department headings on this grand total line *represent the billing to each productive department for storage and transport service*

Whether the amount so billed to a particular department is further subdivided (between production centers) *within* the department receiving the bill is a matter which depends wholly on what type of department it is Only in plural process departments is such further subdivision necessary In the large number of industries in which single, single-series, or single and feeder-parallel types (*cf* Chap XVIII) are alone found, the amounts so billed enter at once into the composition of process cost, as will be described in a later chapter

Storage-transport Factor Charged on Tonnage Basis —When the product is perfectly homogeneous and can be expressed as tonnage or yardage, etc , the final figures of the factor would be sufficiently developed at the *collection* stage In other words, having collected all of the annual costs of storage and transport, they should be consolidated into a single total and simply prorated over production as a separate element in cost at so much per ton or yard Cost would appear something like this

Process cost, Dept 1	$ 45
Process cost, Dept 2	36
Process cost, Dept 3	98
Storage-transport department cost, 12 cts on 25 tons	13
	$182

The only work avoided by this procedure is the allocation of factor charges to departments It can be applied where the product is really homogeneous and can be measured on some simple basis like the yard or pound But before applying this method the greatest care should be taken to ensure that the product really is of such character that no falsity is introduced by treating it all alike The objection is that process costs no longer represent *all* the cost of service to process work, and this objection is a serious one

CHAPTER XXVI

THE SUPERVISION FACTOR

The three factors which have been discussed up to this point are perfectly natural groupings Each of them has a field which is manifestly quite distinct from that of the others The ideas of space rental, power manufacture and the storage and transport of materials are simple and direct, and any items which belong to these factors are easily identified as soon as any attention is given to them

The two next factors with which we have to deal have not such clearly defined fields, although perfectly and easily separable from those already discussed Supervision and organization are activities which are not in their nature so obviously distinct as are, for example, power and transport Any division that may be set up between these two will be to some extent arbitrary, but no very serious results will follow if, in one plant, an item is included under supervision and, in another, under organization As long as the item in question finds its place in *one* of the two, substantial justice will be done

Supervision (of Productive Processes) Factor —The difficulty of treating any definition of the kind exhaustively arises from the fact that hardly any two plants conduct their affairs in exactly the same manner In other words, the actual items which enter into this factor vary greatly from plant to plant All that can be done, therefore, is to give examples which are as typical as possible, and which will enable the reader to grasp the general idea involved, which can then be applied to any given set of circumstances

In the first place it must be understood that the term "supervision" as used in this connection *implies supervision of productive activities only* It does not, for example, include the supervision of the power plant, which is included in the power factor Nor does it include the salary of the storekeeper or of a superintendent or foreman of transport, both of which would be included

in the storage-transport factor Where a special repair department or a special *service* department of any kind is maintained, the supervision of it does not form part of the supervision factor But, on the other hand, any kind of supervision which has to do with the conduct of manufacturing *processes*, including routing, ordering and inspection, is properly included in the supervision factor

Except for the clumsiness of the title, this factor should be termed the *supervision of productive processes factor*

General Superintendence —It may, of course, be argued that some part of the time of, say, the general superintendent, is given to the services represented by factors as well as to the direct operation of processes This is true, but, as the principal object for which both the superintendent and the services exist is to promote process production and as any division of his salary between services and production supervision would necessarily be arbitrary (and would in the end find its way against production), it is convenient as well as justifiable to ignore the fact that part of his time may be given to superintendence of *services* By charging the whole of it to supervision of productive processes, a good deal of unnecessary figuring is avoided without any injustice of importance being incurred

Collection and Distribution of Factor —Like those already described, the working of this factor is conducted in two separate operations First the items are listed and their annual value determined Second, the amounts thus collected are distributed or allocated to the various productive departments concerned The basis of this distribution is, of course, the important matter, and the principles involved will be exemplified most readily by following the course of an actual example, bearing in mind that every plant does not have all the items herein mentioned, and, also, that in some plants other items might have to be substituted

Collection and Distribution Schedule —As the grouping of the items entering supervision factor is simpler and their allocation to departments less complicated than the factors previously discussed, a single blank, of which Fig 70 gives a general idea, will usually suffice for both the collection and the distribution of supervision factor In those cases, however, in which there are several departments having a large number of production centers, a subschedule for each such department will be desirable, only department *totals* being given in the main schedule and transferred

thence to the subschedules for allocation to individual production centers

In this particular case it is assumed that the following arrangements are in existence

a A superintendent, with possibly an assistant and clerks, occupying an office and having general charge of all production

b In each department a foreman, probably occupying an office, and, in the case of some of them, possibly a clerk to assist him in keeping his records There also will be (in some departments) several subforeman, giving the whole or a portion of their time to supervision

Item	Annual Total	Distribution to Production Departments							
		Dept. A	Dept. B	Dept. C	Department D				
					Total	1	2	3	4
Superintendent's Office									
Space Factor	$								
Salaries & Exp	$								
Equipment Chge	$								
Total	$	$	$	$	$	c	c	c	c
Foremen & Sub Foreman									
Space Factor	$								
Salaries & Exp.	$								
Equipment Chge	$								
Total	$	$	$	$	$	c	c	c	c
Production Dept.									
Space Factor	$								
Salaries & Exp.	$								
Equipment Chge.	$								
Total	$	$	$	$	$	c	c	c	c
Inspection Dept.									
Space Factor	$								
Salaries & Exp	$								
Equipment Chge	$								
Total	$	$			$	c	c	c	c
Grand Total	$	$	$	$	$	c	c	c	c

FIG 70

c It is also assumed that the business is of such character that a production department is maintained In this department there will be a control board, orders will be made out, issued, and their progress recorded, rates will be fixed and, possibly, time studies undertaken, and other duties will be carried out, all of which have relation to supervising and facilitating the proper and smooth working of the routine

d In many plants the product will be inspected at various stages Such work may be regarded as an extension of the supervision factor, and it is, therefore, included here

Discussion of the Supervision Factor Schedule—Having thus defined the field to be occupied by the supervision factor, we may turn to Fig 70 and consider each item and group of items both

from the viewpoint of collection and at the same time from the viewpoint of distribution, particularly as regards the *basis* on which each group is to be distributed among the productive departments

1 *Superintendent's Office* —The first item to be included is the space factor for the office, space occupied by the superintendent and his assistants This, of course, has been calculated on the space-factor schedule, and all that is required is to copy the annual total therein calculated Next in order are salaries and expenses These would not be grouped together in actual practice and are so grouped here only on account of considerations of space on the blank Salaries need no explanation Expenses include all stationery, traveling expense, postage, phone charges and similar office expenditures of every kind, such as are met in every office

The remaining item, "equipment charges" is given in this form to save space on the blank Actually, the various items such as desks, typewriters and calculating machines, furniture, etc, would be listed as was done with capital investment items in other factors (*cf* Fig 66) and the interest, depreciation, insurance, repairs, etc, charges brought out in one total It is this total which appears here as equipment charges

Having thus collected all the items of expenditure incurred by the superintendent in his operations, the annual total of all is entered in the Total column opposite the word "total" This amount has now to be distributed to the productive departments

2 *Distributing Superintendent's Expenditure* —In none of the items now to be considered is there any ready-made formula of distribution Each such allocation is a matter of careful judgment on the facts of the case The question to be decided is whether any particular department (or departments) takes up a special share of the superintendent's attention and that of his office If so, then a "loading" must be made to express this extra attention Otherwise, if no one department stands out from the rest in this respect (and this will be the more usual case), then the total in question may be divided between departments on some simple basis which will express their relative importance in the productive process as a whole

3 *Relative Importance of Process Departments* —If all the machines throughout a plant were much of the same value and output, the division might be made by number This, however,

in modern plants is rarely the case. Departments differ in importance because one may have a single large and expensive range of machinery (single-process type) and another several machines varying in size and cost (plural type). Moreover, a costly production center may involve a very simple and otherwise cheap process, while a comparatively cheap machine may involve skilled labor.

The question resolves itself, therefore, into the problem: What expresses the relative importance of a department to the whole productive process? It is a nice point, but in most cases the relative cost of output of each department (excluding direct material) may be taken as satisfying the requirements. As cost of output is made up of all service-factor cost plus all direct labor cost, it is evident that all of the matters demanding the superintendent's care are fully included, and that if one department has an output of $20,000 a month and another department only $10,000, allocation of the item of general superintendence between them in the proportion of 2 : 1 will give substantial justice.

This allocation has been argued at some length because later we shall have to employ the same basis of distribution, namely, the relative importance of departments.

In distributing department allotments between production centers in a (plural type) department such as Dept. D in Fig. 70, the same principle will apply.

4. *Foremen and Subforemen.*—The distribution of this item is self-evident. Each department will be chargeable with the cost of its own foremen and subforemen. In the case of a department like D where a further distribution to production centers takes place, the basis will be the same as that for general superintendence, namely, on the relative output of machines. But if the subforemen's activity is confined, as usually is the case, to certain groups of machines, then only those machines must be charged which actually enjoy this supervision.

5. *Production Department.*—Production department charges need careful scrutiny, if, as may be possible, some of the work of this department does not apply to the whole plant. A control board, for example, may not apply to all departments, as where some side line is carried on, the process routing of which is practically automatic. Time study and rate setting may not be normally applied to more than two or three departments. In

such cases care must be taken that only such departments as enjoy the services come into the allocation of them

Apart from this precaution, and assuming that all process departments share in the activities of the production department, a satisfactory basis for distribution will be that of the number of *delivery points* in each department For the work of a production department is practically confined to either regulating the movements of product to and from delivery points, or it has to do with rate setting at those points, or with making out of orders, which, again, are usually required one for each delivery point With a machine which is not a delivery point, that is, one in a chain of processes, it has usually very little to do, although this is not necessarily a hard and fast rule

It may be said, however, that, as a working rule and unless local conditions point to the absolute inadvisability of it, the cost of a production department may be prorated to processing departments proportionally to the number of delivery points they contain

6 *Inspection Department*—The treatment of this item will depend very much on what form is taken by the inspection service If it is departmental, that is, if certain departments have a corps of inspectors who control the quality of work in those departments, then only such departments are chargeable with their own expenditure But if inspection is conducted only at the end of the chain of processes, that is, it is a *final* inspection, then the cost of the inspection department should be prorated over departments on the now familiar basis of their relative importance

Some care is, however, necessary If departments exist the product of which does not come under this final inspection, they will be exempt from bearing any portion of the expenditure on it

7 *Grand Total of Supervision*—When all of these allocations have been made, addition of the department columns will give the total charge or supervision factor to be made against each In the case of departments like D, wherein a further distribution has to be made to individual centers, totals against each such center will be found in the columns headed 1, 2, 3, 4, etc , which are merely subdivisions of the department total

Conclusion—When all of these operations have been carried out, the different groups of activities which have been included

here under the term "supervision" will have been charged (or, rather, their annual cost will have been charged) to each department *in proportion to a reasonable idea of what such department enjoys of the activities in question*. A small department will have a small share, a large department a large share, provided, that it has any share at all. By this is meant that the cost of a group is not charged haphazardly over all departments. While general superintendence is unquestionably chargeable to all departments in some degree, and all departments will certainly take up part of the cost of foremanship, it does not follow that all share in the cost either of the production or the inspection department. If these exceptions are carefully watched, there should be no difficulty in making a fair, reasonable and argument-proof distribution of the supervision factor.

CHAPTER XXVII

THE ORGANIZATION FACTOR

The organization factor embraces a considerable number of the items charged as "general expense" in the old system of costing. It does not, however, include all of these. For example, the so-called "fixed charges," as has already been shown, are not considered as forming a chargeable class by themselves, but are debited, piecemeal, to the various service factors for whose aid they are incurred. But such expenditures as the cost of the higher administration and of various minor services only vaguely connected with productive processes do enter this factor. Among these latter may be cited watchmen, fire protection, medical and safety service, welfare and employment, etc.

Relation to Process Cost.—It will be sufficiently obvious that between such expenditures and that on productive processes there is less natural connection than is the case with the space, power, storage-transport and supervision factors. All of these do have a more or less observable relation to production. There share in promoting it is fairly obvious and is, therefore, measurable to a sufficient degree. The use of space is obviously related to the size of machinery, the use of power can be (and in practice should be) actually metered to the productive process, the cost of storage must obviously have some relation to the output of processes and the cost of transport an even closer relation. We may picture plant and department supervision as being shared in proportion to the output of the thing for which supervision is required, namely, product. But when it comes to the costs of the higher administration, that of presidents, general managers, comptrollers, and so on, and of such general services as those relating to watching, fire protection, safety and health, it is evident that any proportionate connection becomes hard to picture. One reason for this is that some, at least, of these services could be intermitted without any *immediately* visible result on production, while space, power, storage-transport and supervision could not be cut off without bringing the productive processes speedily to a halt.

It is perhaps fortunate that, when aggregated, the charges for such items do not bulk large in costs In other words, among the elements of process cost the organization factor is, perhaps, the least important Its importance will, however, vary considerably according to the industry and also to the way in which the business is organized The activities included in it are of course, as vital to the success of the business as other more directly measurable activities and, to an equal degree, are to be ranked as legitimate costs of process production

It is true that the relation of some of the items that enter into organization factor are more definite in their incidence than others The expense of the purchasing department, for instance, is usually connected with the amount of stores purchased The expenditure on time, pay and costing activities stands in a somewhat closer relation to output than other groups The work of the employment department has relation to turnover at least Consequently, when we come to settle the basis of distribution for each group we shall find more natural relations existing in some cases than in others This will be better understood after each such group has been considered separately on its own merits

Collection and Distribution Schedule —Figure 71 exhibits the general form of a schedule which serves both for collection and distribution of organization factor charges It is of exactly the same character as that used for supervision factor, and, therefore, the meaning of the sub-items "space factor" "salaries and expenses," "equipment charges" will not need further explanation, having been fully treated on page 305 in the previous chapter Only the totals of each group of expenditure or sub-service will be enlarged upon

Division between Selling and Production —Before considering the organization schedule in detail, it is necessary to call attention to an allocation of factor charges with which we have not hitherto had to deal The work of the general office, and sometimes of other subservices included in the organization factor, *is not wholly devoted to the promotion of production* Some of it goes to the promotion of sales of finished product In other words, the organization factor is one which, in regard to some of the items that make it up, must be prorated between the selling organization and the plant

	Ann'l Total	Sales Dept	Production Depts							
			A	B	C	Dept D				
						Total	1	2	3	4
General Office										
Space Factor	$									
Salaries & Exp	$									
Equip Charges	$									
Total	$	$	$	$	$	$	c	c	c	c
Purchas'g Dept										
Space Factor	$									
Salaries & Exp	$									
Equip Charges	$									
Total	$	?	$	$	$	$	c	c	c	c
Cost, Time, Pay										
Space Factor	$									
Salaries & Exp	$									
Equip Charges	$									
Total	$	?	$	$	$	$	c	c	c	c
Watch & Fire Dept										
Space Factor	$									
Salaries & Exp	$									
Equip Charges	$									
Total	$	?	$	$	$	$	c	c	c	c
Employment Dept										
Space Factor	$									
Salaries & Exp	$									
Equip Charges	$									
Total	$	?	$	$	$	$	c	c	c	c
Medical or Rest Dept										
Space Factor	$									
Salaries & Exp	$									
Equip Charges	$									
Total	$	?	$	$	$	$	c	c	c	c
Safety Dept										
Space Factor	$									
Salaries & Exp	$									
Equip Charges	$									
Total	$		$	$	$	$	c	c	c	c
Grand Total	$	$	$	$	$	$	c	c	c	c

FIG 71

In dealing with space factor, a portion of the annual cost of space was charged (*cf* Fig 62*a*) to "office and organization," that is, to the present factor The space factor charges in the organization schedule (Fig 71) may be considered as derived from Fig 62*a* These space-factor charges, each being included in a subservice, will thus eventually be prorated between selling and plant None of the other factors is concerned with selling The selling department does not consume steam or current (except as included in space factor for heat and light) It does not use stores or transport within the plant It makes no use of any part of the plant supervision Selling and production expenses are, therefore, mixed in certain limited services only, and the degree of this mixture varies from business to business

In some instances there will be but little prorating to be done The sales organization may not be located at the general office of the plant but in a distant city In this case it does not enter into the organization schedule at all, but there is still the question of the time of higher officials to be considered These must be prorated between selling and production

More often, the sales organization will have its headquarters at the general office Then it will be necessary to analyze the general office expenditure and classify it in the two main divisions —selling and production This kind of division is necessary whether the factor method or any other of the older systems of costing is employed

Allocations on the Schedule—We may now return to Fig 71 and consider the allocations of each item or subservice in detail The first of these is

1 *General Office*—Having sorted out items which pertain wholly to selling, there remains the question of the officials whose time is given to both activities The president and vice presidents, the general manager, the comptroller or chief accountant will suggest themselves here In each case the division is likely to be somewhat arbitrary Each man must judge what portion of his time is normally given to the problems of selling and production, respectively, and his salary may be divided up on that basis The same principle must apply to the work of the office staff, the clerks, stenographers, accountants, etc It will not be difficult to ascertain roughly what amount of time is given to work in connection with selling Some individuals will be working wholly on selling matters, others wholly on produc-

tion matters It is only those who work on both that will require their time divided in the manner suggested

The work of the cost, time and pay departments will, in any case, be separated from the others, if these departments are located in the general office building Cost, time and pay will be found in the organization as a separate subgroup

When the division into plant expenditure and selling has been made, we may proceed to consider the allocation of the former With the latter we have nothing to do It is charged to the sales department and we have no further concern with it

The matter for consideration is, as usual On what basis shall the general office expenses be charged to the various departments? Any basis must necessarily be arbitrary, because the two kinds of activity are wholly independent, although, in a general sense, proportionate to each other to some extent All things considered, the most convenient basis will be that used before, namely, the relative importance of the departments as indicated by the value of their output at full time

In the case of a department like D (*cf* Fig 71) in which there are several production centers, the amount allocated to the department will be further prorated over the production centers themselves on the same basis, that is, on the relative value of their output at full time

2 *Purchasing Department* —It may be asked why the purchasing department is not included in the storage factor instead of the organization factor It may be so included in many plants, but it is included in organization factor here to illustrate a possible variation that might otherwise be puzzling The work of a purchasing agent *is not always confined to buying materials for manufacture* Sometimes he buys goods for resale by the selling department, such goods having nothing to do with the plant and not, necessarily, coming near it Obviously, where this is the case, the cost of the upkeep of the purchasing department must be shared between selling and production, hence the question (?) mark against this item in Fig 71

Assuming this division to have been made, the basis of allocation of the portion chargeable to the plant is the next question This will most conveniently be made on the same basis as the allocation of general storage charges (*cf* Chap XXV), namely, in proportion to the amount of material consumed by each department on the average

3 *Cost, Time and Pay Departments* —The allocation of this subclass of expenditure is perhaps a little illogical Some of the work of these departments is obviously given to figures pertaining to services The logical course would be to prorate the expenditure between service-factor departments, such as the power plant, storage-transport department, etc , as well as between productive departments A, B, C, etc To do so would, however, complicate the accounting, and, as in the end, the charges would eventually find their way to productive departments via the factors in which they were included, perhaps no substantial injustice is inflicted on accuracy by ignoring service departments and prorating *all* the cost of the cost, time and pay departments over productive departments

It is assumed that if any portion of the work of such subservice is concerned with selling, that portion will be charged to selling department The question mark in selling column opposite this item signifies this assumption

The basis of allocation to productive departments may be, as before, the relative importance of each

4 *Watch and Fire Services* —Cost of these services may be prorated on the relative importance basis, or, if desired, as these services have some relation to property, the *value* of the plant, building and equipment in each department may be taken as a basis, added to the value of work in process usually remaining overnight in the department

5 *Employment Department* —The same difficulty applies here as was met in the case of the cost, time and pay departments Some of the services will make use of the services of the employment manager and his organization Nevertheless, as in the former case, no substantial injustice will be done if the allocation of employment department expenditure is confined to productive departments The basis of such distribution should, obviously, be connected with the main feature of employment, namely, turnover In some departments there will be a larger number of transactions than in others Distribution should be in proportion, therefore, to the turnover of labor in each productive department

6 *Medical and Rest Service* —Expenditure on this minor service should be in proportion to the number of employees in each productive department, unless certain departments make a disproportionate call on the service

7. *Safety Department*.—This also has relation to the number of employees and should be chargeable to productive departments on that basis. In both this and the previous subgroup, service departments are ignored, but the minor nature of the expenditure will allow this to be done without important prejudice to accuracy.

8. *Grand Total of Organization Factor*.—When all of the allocations have been made, as above, and all of the subgroups accounted for, then addition of the department columns will provide the total organization factor charge against each department. In the case of departments like D, having several production centers, the further subdivision can be made on this schedule, as shown in the case of D. But if several departments have to be subdivided in this way, or if a large number of production centers are included in a department, then it will be better to allow only the departmental column to appear on this schedule and use additional or subschedules to effect the further distribution to individual production centers.

Conclusion.—The organization factor is the least satisfactory and argument proof of all the factors. But, while this is true, the disposal of the items included in it is certainly not more unsatisfactory than with the pool of "general expense" that accumulates on the older systems and is plastered onto work on some arbitrary ratio basis.

That many of the items in organization factor have no natural relation with production costs is obvious, but nevertheless, they, or some of them, do bear a vague proportional relation to the productive process *as a whole*. In a plant of large manufacturing capacity, they will be higher than in a plant of small manufacturing capacity. If, therefore, the total is charged among departments on some basis which expresses the relative importance of these departments in the productive process, the solution of the difficulty will be placed at least on arguable lines. By this is meant that while some observers may prefer to allocate some of the items on other bases than here indicated, the reasons for or against are capable of expression and valuation. By the old method of ratios neither argument nor valuation is possible. A ratio is an arbitrary, and to a great extent an accidental, solution of the difficult problem of administrative charges. Organization factor is at least an improvement on that.

CHAPTER XXVIII

THE PRODUCTIVE EQUIPMENT FACTOR

We have now covered the principal active factors which represent services *to* productive processes. We have accounted for the *space* occupied by productive departments, the *power* used by them, the cost of *storage and transport* of the material on which they work and the expenditure on *supervision*. In the last chapter *organization* factor was discussed, which deals with certain more general charges incurred by the business for the sake of productive processes.

Now we have to deal with the productive equipment itself. This is to a large extent a passive factor. It contains no living agents, except in a very indirect way (cleaning and repairs). On the other hand, it represents the charges due to investment in productive equipment and its upkeep, in a strictly defined and limited sense.

Definition of Productive-equipment Factor.—All of the factors hitherto described represent services *to* productive processes. Now we come close to the productive process itself. The services hitherto described play, as it were, all around the actual productive equipment but do not touch it. As a process is carried on by equipment, that is, by a machine, or chain of machines, it becomes necessary to bring into account the annual charges due to the capital investment locked up in such machine, and also the cost of keeping this value as constant as possible, *i.e.*, maintained and repaired. To these main expenditures may be added the cost of lubrication, waste and small sundries of similar character and the cost of cleaning the machine, of which more will be said later. The elements of productive-equipment factor will, therefore, include interest and depreciation, insurance and taxes on the capital value of the machinery and (where motor drive is built in) of the electric equipment, an annual charge for the value of belting used, the cost of keeping the machine clean and of supplies.

The total of these items will amount to an annual sum, which, in the case of a single-type department (where there is only one

machine or chain of machines), will simply be chargeable against such department In the case of a plural-type department (in which there are several independent production centers), the calculation will be made for each such center separately and the total for the department will be simply the sum of the annual totals for each center

Productive-equipment Factor Schedule—In Fig 72 will be found the general idea of a schedule suitable for both collection and distribution of this factor This will be discussed item by item

Productive Equipment Factor	Ann'l Total	Sales Dept	Production Depts								
			A	B	C	D					
						Total	1	2	3	4	
Cap Invest Chgs											
Machine											
Int & Dep	$		$	$	$	$	c	c	c	c	
Insurance	$		$	$	$	$	c	c	c	c	
Taxes	$		$	$	$	$	c	c	c	c	
Repairs etc.	$		$	$	$	$	c	c	c	c	
Motor											
Int & Dept	$		$	$	$	$	c	c	c	c	
Insurance	$		$	$	$	$	c	c	c	c	
Taxes	$		$	$	$	$	c	c	c	c	
Repairs etc	$		$	$	$	$	c	c	c	c	
Beeting	$		$	$	$	$	c			c	
Cleaning	$		$	$	$	$	c	c	c	c	
Supplies											
Oil	$		$	$	$	$	c	c	c	c	
Waste	$		$	$	$	$	c	c	c	c	
Sundry	$		$	$	$	$	c	c	c	c	
Grand Total	$		$	$	$	$	c	c	c	c	

Fig 72

1 *Investment Charges Machine*—The only point that may require explanation in regard to this item (the operations of calculating interest and depreciation, etc, being precisely the same as on all other equipment and also the allowance for repairs and maintenance) is the exact scope of the matters to be included A productive process may be carried on by a very simple and definite machine, such as a drilling machine, or, on the other hand, it may (more particularly outside the machine tool using industries) be made up of main and auxiliary equipment, which is sometimes not very easy to distinguish In a mercerizing

department, for example, the caustic supply and recovery is an auxiliary matter of this kind The point may, however, be put in general terms as follows

What Constitutes Productive Equipment—Suppose we have a productive department A in which there is a single machine performing a process Further, let it be supposed that the machine in question circulates a liquid and that for the purposes of the process this liquid has to be pumped to a cooling tower and returned to the machine, either continually or at frequent intervals Is the cooling tower to be included as part of the process?

The answer is in the affirmative, if such tower is maintained entirely for the use of this one machine Even though physically separated from the department it serves, it should be scheduled as a separate department in the first instance, in order to gather space factor and other charges and then consolidated with the department to which it belongs For the present purpose, that is, equipment factor, it will be reckoned in its own "cooling tower department" and the combined result transferred to Dept A

But if the cooling tower is not used wholly and entirely for the process carried on by Dept A but also serves another department, say G, then it must be treated as a service department and a cooling tower factor set up, the service so carried on being charged to A and G in the proportion normally enjoyed by each (see next chapter)

These are perhaps rather obvious cases, although it is desirable to note them Next may be considered the case of a department in which the main machine is served by auxiliary equipment such as a large steam pump or a special machine for grinding knives for the use of the ordinary operator or operators of the process In these cases the pump and the grinding appliance may be considered as part of the productive equipment As they are entirely subordinate to it and do not serve any other process, they may be regarded as part and parcel of the process, notwithstanding that they do not actually work on product

Some care is necessary in grouping auxiliary and main equipment A good working rule is If the auxiliary appliance exists wholly to promote the process and does not serve any other process, its equipment should be ranged alongside the main equipment in this schedule, just as the built-in motor is so listed A touchstone by which to decide is to ask If this auxiliary does not

form part of this process, where else is it to be charged? A little reasoning of this kind will quickly clear up a doubtful case

To return to the consideration of the schedule (Fig 72) The next item listed is

2 *Motor* —It might be assumed that the proper place for all motors is in the power factor, inasmuch as it was stated in Chap XXIV that power factor has to do not only with the generation of steam and current but also with its delivery to the point of consumption If the current were used to drive a large motor on a line shaft serving two or three machines, the motor and the shafts and belts would belong to power factor But in the case of a machine with a built-in motor, which forms a self-contained unit, it would be rather pedantic to tear this unit apart for the sake of putting the motor in one factor and the machine in another In fact, the only motive for listing the motor separately is because a motor wears out more rapidly than a machine, generally speaking, and on this account the machine and the motor take quite different depreciation rates A built-in motor should, therefore, be treated as a separate item in this schedule

3 *Belting* —This refers to belting in and about the machine itself Many machines have one or several belts (or chains) connecting their work parts The annual cost of such belting should be entered opposite this item

4 *Cleaning* —In many plants it is customary, in the last hour of the working week, to shut down production and allow the operators to clean their machines The time of direct operators so employed should not be charged (as is too frequently the case) to the jobs which happen to be on the machines at the moment It should, on the contrary, be charged to a special service order number "cleaning productive equipment" To absorb the charges which would thus be accumulated, the item "cleaning" is included here The amounts to be entered will be based on the hourly wage of the operators concerned In the case of departments with large machines having a group of operators, more care is necessary, and the practice of the department should be ascertained so as to make the proper allowance

5 *Supplies* —In connection with every machine minor supplies, such as lubricating oil, grease, waste, emery paper, etc , are employed from day to day A reasonable allowance, having in view the size and type of machine, should be made to cover

the annual cost of these supplies. In some machines oil is used as a processing lubricant, *i.e.*, it is consumed very much in proportion to amount of product. It becomes, thus, a processing material (*i.e.*, direct material) but, on account of the very small nature of the item, such use may very well be included here, unless the oil is of some special expensive variety.

6. *Grand Total of Factor.*—When all items have been entered, addition of the columns will furnish the charge to be made against each department for the use of the productive equipment it contains. As before, subdivision among production centers where the department contains more than one process can either be made on this blank or on separate subschedules. The total against the department, in the case of several production centers, is merely the total of all such centers taken together.

Conclusion.—The productive-equipment factor is obviously a perfectly definite and separate one. It cannot be confused with any other class of service charge as its field is strictly limited. The only ambiguity likely to be met, and this in only special cases, is to define exactly what is, in any given department, really productive equipment pertaining to process work and to one process alone. There is no real difficulty involved in this except that somewhat careful inquiry into the uses of equipment must be made. But as all equipment must find its place in some factor, either as performing service or doing process work, very little inquiry should serve to show in which class a doubtful item should be included.

CHAPTER XXIX

SPECIAL SERVICE FACTORS

While the average plant in most industries may not require service factors additional to those already enumerated, some plants do call for additional services, which must have special factors set up to take care of them

It may be stated, as a general principle, that *every separate kind of business outside the straight line of productive processing* that is undertaken by the manufacturer to help along his main object (which is the processing of salable product) must have its own factor, just as the business of being a landlord necessitates a space factor and the business of running a power plant requires a power factor

If it becomes necessary in the course of operations to take up some outside line, such as the preparation of oxy-hydrogen, chlorine or heating gas and its supply to the productive processes or some of them, or, if a tool room has to be maintained in order to keep the productive machines adequately supplied with tools, jigs, templets and special rigs, then, in all of these cases, we, first, must *ascertain the cost of doing this additional and separate business*, and, next, proceed to charge its cost, by means of a special-factor charge, into processes on the basis of their individual use of the service so provided

Two Classes of Special Factors —Special factors (which are so termed only because they are not common to more than one plant or, at most, to more than one industry at a time) may be divided into two main classes, *viz* (1) those which supply a *product*, such as the gas mentioned above, and (2) those which supply a *service*, such as tool-room service No particular operative importance attaches to this classification, but it is useful to remember that both a service and a product can adequately be handled by the factor method

The principal factors already described can also be classified in this way Steam and electric current are products, and, therefore, power factor deals with the supply of a product

Supervision, on the other hand, is a pure service, and belongs, therefore, in the other class Whether for a product or a service, no difference in the manipulation of the elements of the factor is necessary

Elements of Cost of Special Factors —The elements of the cost of a special product or service are much the same, except that in the latter case usually no material is consumed For the sake of clearness, however, it may be well to consider each class separately

1 *When the Factor Represents a Product*—The making of anything implies at once a place in which it is made The first item of a special factor of this class will, therefore, be space factor for the use of the land area or of the building utilized for this purpose Most frequently the product will require steam or current, or both, thus a power factor will be necessary These two factors will be charged exactly as though the work were that of an ordinary productive department The cost of storage of the materials used on the work and of any transportation line maintained for the factor will be included under labor, investment charges, etc , just as fuel and ash handling and storage was included in power factor Supervision will be confined to the wages of the foreman in charge of the work No organization factor will be charged

The usual interest and depreciation, insurance, taxes, repairs and maintenance charges on the capital investment in the special plant and equipment employed on the work will, also, be chargeable to the factor

The above charges will account for all of the expenditure on the work, except that of labor and the cost of the raw material used The addition of all of these items gives the cost of the product, which will be divided by the quantity produced to get a cost per unit In tabular form these items may be set out as follows

1 Space-factor charge (through additional column in space schedule)
2 Power-factor charge (at standard rates for steam or current)
3 Supervision (actual wages of foreman)
4 Interest, depreciation, insurance and taxes on the capital value of the plant and equipment
5 Repairs and maintenance of the equipment
6 Labor (actual wages of all labor employed on the work)
7 Material (actual cost of all materials used on the work)

The charges to process work will be based on the actual use made of the product by each process. To each process *using* the product a charge will be made at so much per unit used in the year, the amount used per hour being the fundamental basis of this calculation.

2. *When the Factor Represents a Service.*—Many of the items entering into a special factor, when it represents a product, will be found to apply when it represents a service. This may be illustrated by the example of a tool-room service which is found in many plants of the machine tool using type. First, a space has to be set apart for the storage of tools and for the machines used to repair them. Power will be required for the machines, although it may happen that repairs are done elsewhere in which case there would be no charge for power. Interest and other such charges will be chargeable for the equipment, storage shelves and bins, even if there are no machines. As a rule there will be no storage-transport charge, the department doing its own storing and also having its own collection and delivery service. A foreman will usually be in charge of the work and his wages and those of his assistants, mechanics and messengers will enter into the factor. There will also be some expenditure on supplies, especially if repairing is done in the tool room. The total of all of these charges represents the cost of the tool-room service and must be prorated over processes on the basis of the call by each on the service.

Auxiliary Equipment.—It should be noted that the factor as arranged above *does not include any part of the cost of the auxiliary appliances,* tools, jigs, templets, etc., which it handles. It merely includes the cost of keeping them, repairing them, perhaps, and issuing them to the points at which they are wanted and collecting them back into safe-keeping.

The cost of auxiliary equipment that is detached from the machine using it is a very troublesome question and will be briefly dealt with in a special chapter.

Special-factor Schedule.—Figure 73 exhibits the form of schedule, uniform with others already described, which may serve for both varieties of special factor. The items listed have been discussed. It is understood, of course, that some of these may not be represented in any given special factor, in which case there will be no entries opposite such items. On the other hand,

it might happen that some unusual item was found to be necessary and this would take its place in the list

When all of the items have been assembled on the basis of their annual cost, a total for the whole factor is obtained *Only the total is prorated*, and, before prorating is possible, some satisfactory basis of unit charge must be arranged

Special Factor	Ann'l Total	Sales Dept	Production Depts								
						D					
			A	B	C	Total	1	2	3	4	
Space Factor	$										
Power Factor	$										
Cap Invest Chgs											
Int & Dep	$										
Insurance	$										
Taxes	$										
Repairs, etc	$										
Foreman	$										
Wages of Labor	$										
Material used	$										
Sundry Supplies	$										
Total	$		$	$	$	$	c	c	c	c	

FIG 73

Basis of Charging Special Factors —This basis will obviously vary according to the kind of work done by the factor If a special product, such as hydraulic power or compressed air is in question, the difficulty will frequently arise that the use of such a service in a given process is exceedingly intermittent, although sometimes the actual motive power of the process may be derived from such a source Assuming that pressures are constant, the charge to processes might be made on the *time* during which the power was "on" Suppose that ten processes use the service and that each of them turns the power on for an aggregate time of 3 hr a day, this would imply 3×10 or 30 hr total use The day's cost of the factor would then be divided by 30, giving the cost of an hour's actual use Each process would then be charged with as many hours as it employed The annual charge would be calculated accordingly

When the service is not intermittent, as, for instance, where gas is manufactured to be supplied to several heating furnaces in different departments, the problem is simpler Each department

using the gas can be metered (and this should certainly be done in the interests of economy) and a charge made in strict proportion to the *annual consumption under full-time conditions.*

In the same way the cost of a *service* is prorated in proportion to the call for it by each process. If no call is made, there is no charge. The processes sharing in the service are listed and a figure set against each which fairly represents the proportion of the service it consumes. Division of the total cost of the services in these proportions will follow.

Conclusion.—The general principle involved in all special factors is the same. First, we engage in a special business of which we ascertain the total and inclusive cost. Second, we proceed to bill our customers (processes) for their use of the product or service in question just as though we were selling to an outsider. This implies two things, first, that we shall be able to tell how much service we have delivered in total, and, second, how much each customer (process) has taken. No royal rule for doing this is applicable to all services, but the basis of charging any particular service will, usually, need very little deliberation. In some cases the assistance of a technical expert familiar with the service and the manner in which it is employed will facilitate a satisfactory solution.

CHAPTER XXX

REPAIRS AND MAINTENANCE

It might very well be argued that repairing of buildings, machines, equipment and tools was a service precisely equivalent to any other service This view would probably be taken in non-engineering industrial plants wherein it is usual to have a "repair department" just as often as a power department It would be a pertinent question to enquire why the two departments are not treated alike

Should a Repairs and Maintenance Factor Be Set Up?—There would be no great difficulty in setting up a factor for all repair

Expenditure on repairs and maintenance being aggregate of charges to factors	$	Repairs and Maintenance	
		Space factor	$
		Power "	$
		S-T "	$
		Suptce "	$
		Prod eqt "	$
		Organization factor	$
		Special "	$
Total	$	Total	$

Fig 74 —Repairs and maintenance

and maintenance work To this factor would be charged all expenditure on the work, and the various charges already made against capital investment items in all factors for such work would be considered as charged out from the factor The resulting figures would be scheduled in this form (Fig 74)

The *expenditure* on the factor is seen, however, to be merely a contra to the charges to factors This is because, in most cases, much of the repairs is likely to be done by outside firms, especially building repairs There is, therefore, no basis on which to schedule expenditure in advance, beyond reckoning up the charges made to factors This would be merely an arithmetical device, which, while apparently setting up a factor like other factors, would really be of no value at all

Control of Repairs and Maintenance Charges —It must be remembered that factors are a *standardization* of expenditure The total of all the charges for repairs and maintenance, therefore, provide a fund out of which such expenditure can be made If the plant is working 100 per cent of standard working hours, then the figure on the left hand of Fig 74 will be the total sum charged into cost on account of repairs Some of this amount will be expended with outside contractors and the remainder expended in the firm's own repair department or equivalent It is important that the scheduled amounts in the factors should ultimately correspond closely with the actual expenditure for repairs and maintenance This, however, is a matter of control which will be dealt with in Chap XXXVI

When a Repair Department Is Maintained —In the non-engineering type of industry, a mechanical department equipped with machine tools is generally to be found in plants of any size Most of the repairs to machinery, mechanical equipment, piping, etc , will then be carried out by this department, although there is likely to be work done by outsiders as well, especially in connection with buildings The present question is how such a repair department shall be dealt with under the factor system

A column will have to be provided for it on most of the schedules It will take space factor and power factor, and, in general, will have some call on the transport service Supervision factor will not be chargeable, except for its own foreman, as this is an expense department Organization factor will also not be charged to it Special factors may or may not be If, for example, it took hydraulic power, it would appear on the hydraulic power factor

Aggregation of these factor charges will give the cost of running the department under normal conditions But the chief reason for including such a department in the factor schedules is to account for all of the service supplied throughout the plant The only use we can make of the standardized cost of running the department is, at the year end, to compare it with the actual expenditure, and this latter, added to the bills received from outside contractors for repair work, should equal the total of all repair and maintenance charges to factors In other words, repairs and maintenance *are standardized by calculations on each item of equipment and not by a standardization of repair department expenses* The latter only check the general accuracy of the

total expenditure on this item, they are not inclusive, and the real check is the detailed repair charges billed from outside and inside repair sources, when set against the corresponding items in the schedules

Maintenance —The expression "repairs and maintenance" is usual in all accounting If there is any difference between repairs and maintenance, it is that the former comprises work on equipment which is obviously in need of it or actually broken down and damaged in some way, and the latter comprises preventive work It represents the "stitch in time" General overhauls are in the nature of maintenance rather than repair, but, as a matter of fact, the line cannot be drawn between the two terms with any precision, nor is it at all necessary to do so The treatment of both kinds of expenditure is absolutely the same from all accounting viewpoints

CHAPTER XXXI

AUXILIARY EQUIPMENT

In some industries, more particularly those which are based on machine tool using, a costing problem of peculiar difficulty will be met in regard to what may be termed "auxiliary equipment" As this class of equipment almost defies standardization, in many instances, some attention is necessary to its problems

Auxiliary Equipment Defined—Auxiliary equipment may be roughly divided into two classes (1) tools, such as drills, files, milling cutters and, indeed cutting tools on any kind of machine, (2) jigs, templets, molds, patterns, etc, which are appliances constructed to *assist* production either as accessories to a machine process or, as in the case of molds and patterns, directly usable in process work Most of these latter appliances are extremely special in their range While tools and cutters usually are applicable to a variety of jobs, a jig, mold or pattern is intended to effect some one change of material and will not, as a rule, be available for any other kind of job whatever

Nature of the Difficulty Encountered—Each of these classes has its own problem, and they are different Tools and cutters wear out in course of use, and it is difficult to assign a proper charge for their use, since this rate of decay is not necessarily constant for all jobs Jigs, molds and patterns also wear out, but this is not the principal difficulty encountered in regard to them The real difficulty arises from the fact that all, or most, such appliances have *an indeterminate life* With a machine or a building we may take it as moderately certain that a given depreciation rate will charge the capital value of such machine or building into costs with reasonable accuracy In any case the long life of either of these types of investment makes it possible to safeguard by increasing or decreasing the rate, if in course of years there is reason to do so

With the second type of auxiliary equipment, however, the reasonable life cannot always, nor indeed often, be determined in advance Under such circumstances the prospects for charging

into costs by means of a depreciation rate are not very bright In other words, a *basis* for charging the cost of auxiliary equipment into cost is frequently lacking

Relation to Standardization —It must be remembered that what we are now considering is not the *cost* of such appliances, which is just as easy to obtain as the cost of any other product, it is the disposal of the cost, when ascertained, that presents the difficulty If, for example, we have made a jig which is to be used on a milling machine for a certain job, the charge which should be made to the process for the use of the jig will depend mainly on how many times it is used If we were sure that it would be used over and over again until it was worn out, there would be less difficulty in the matter We should have to calculate approximately how many jobs the jig would do This would be, in practice, a depreciation rate based not on the lapse of years but on repeated use Then, whether these jobs were done one after another or whether they were put in hand at intervals would make no difference So much would be charged for each time of using the jig

This would be a *standardized* charge Whether or not it was a correctly standardized charge would only be proved when the jig was worn out, when a comparison of the earnings of the jig (at standard charge) with its original cost would prove the result If the jig were wearing visibly at too fast a rate, it would be possible to modify the rate accordingly

But no standardized charge can be made if we do not know how many times the appliance will be used, and this is very often the case, but not always, because continuous mass production, say of typewriters, will use jigs with a fair certainty that their use will be continuous Depreciation can then be made as with any other equipment Similarly, with the large and expensive molds used in casting steel billets Each mold is expected to make so many tons of billets and the basis of calculation is therefore complete But with an indeterminate life no such basis is discoverable

Indeterminate Life —The reasons which give rise to an indeterminate life in the case of so many patterns, molds, jigs, etc , are numerous In the case of lasts used in the shoe industry, changes of fashion are the determining element In the machine-shop type of plant, a line of manufacture may be lost by competition or because it is not a commercial success Orders may be

taken involving the making of auxiliary appliances, with no *certainty*, even though there may be strong expectation, that such orders will be repeated many times Indeterminate life is, therefore, a problem that cannot be evaded or countered by any foresight or precaution It is inherent in our trade customs and nothing can be done about it

Necessity for Some Solution —Nevertheless, in those industries which must of necessity make and use auxiliary equipment, it is obvious that some solution of the problem must be found This is true in all types of costing and not only under the method of standardization by factors and process rates It is absolutely necessary that the cost of a job must include a charge for jigs, molds, patterns and tools used in connection with it That this charge is a quite arbitrary one cannot be helped That it will frequently turn out to be incorrect cannot be helped either Under these conditions it may be supposed that we must plan for safety

In some cases this is feasible, but not always For example, an order may be taken for a thousand articles, involving the making of auxiliary equipment, the cost of which represents a considerable proportion of the profit that is expected to be made on the order Two courses are then open (1) the whole of the cost of auxiliary equipment may be charged at once to the order, and the price based on that, or (2) part of the cost of the auxiliaries may be held up or suspended in the hope that future orders will wipe out the balance so held over

In the first case, the charging of all the auxiliary costs at once may result in missing the order, if the bid is based on that principle In the second case, the order may be received, which would result in making but a small and inadequate profit on it, and, after all, with no further orders forthcoming This presents a dilemma from which there is no apparent escape

Practicable Bases of Charging —The practicable courses for charging auxiliary equipment can, therefore, only be very sketchily outlined, inasmuch as the solution of any particular problem depends upon a close weighing of all the circumstances and the subsequent exercise of judgment, and sound judgment at that, on all the possibilities of the case

1 In the case of tools and cutters and all similar appliances, it will probably be found that a tool charge may be made to the process that will cover with fair accuracy the cost of whatever

tools are employed from time to time Even then jobs demanding special and expensive cutters will endanger this solution unless care is taken Extra tool charges should be made in such cases to the job itself, as well as through the standard tool charge to the process This, however, is a matter of costing and not of standardization *The standardized charge should be adjusted to care for the average use of the tools on a particular process*

2 In the case of auxiliary equipment specially made for certain kinds of work of a continuous nature, as for patterns used in a regular foundry product or as in the case of the billet molds already cited, it will usually be possible to fix a reasonable depreciation rate based on output In case that a given process is continuously employed on similar work, this standardized charge (including not only depreciation but also interest, insurance and repairs) can be included in a process rate in the ordinary way

3 In the case of auxiliary equipment specially made for a particular *job*, the charge for the use of such equipment must be made to the job itself and not through a process rate Just how much of the cost should be charged on the first occasion and how much should be held over for future repetitions of the job is a matter of pure judgment and no rule can possibly be laid down for it

CHAPTER XXXII

BUILDING THE PROCESS RATE

I SINGLE-TYPE DEPARTMENTS

It was pointed out in Chap XVIII that departmentalization is a controlling influence in the setting up of a cost system Whenever it is possible to carry departmentalization as far as single processes (and in some industries this arrangement is not only easy but the most natural and obvious), then costing operations are at their simplest possible stage

Single-type Departments —On reference to Fig 50 it will be seen that single-type departments may be of three different varieties There may be only one machine or chain of machines with a single delivery point There may be several such machines or chains of machines all exactly similar, each with its own delivery point Or there may be an arrangement of machines, which was termed the "feeder-parallel" type, in which there is a different number of machines at various links of the chain of processes, although material flows through the whole chain in a uniform manner In this type there may be either one or several delivery points, according as the work flows through an arrangement like that shown at C in Fig 50 from one end or the other

Time the Only Variable —In single-type departments there is only one process, however many delivery points there may be Consequently, the only difference in the treatment of jobs or lots of work will be in the time taken by a job or lot to pass through the process In some industries even this variable does not come into account, inasmuch as the speed of processing is fixed and unalterable In other industries the speed of processing may vary according to the nature of the fabric or other material being processed Or it may be necessary, in a few cases, to run the material through more than once in order to obtain the desired result This latter condition, from a costing viewpoint, is precisely the same as though two different lots of material had been processed, except that both processings are chargeable to the same job or lot number

Recording Time on Jobs or Lots —Where the speed of processing is invariable, so that the time taken by any one lot to pass the delivery point is strictly dependent on the number of pounds, yards, square feet or other unit of measure contained in it, it is obvious that no timing of *individual jobs or lots* will be required If it, for example, always takes 1 hr to process 100 units of product (pounds, yards etc), then, if 800 units have been processed in a day, the total processing time will have been 8 hr And if the cost of the process-hour is $5 and a lot contains 200 units, the cost of processing of that lot is (200 ÷ 100) × $5, or $10

In a case of this kind nothing would be gained by recording the time of processing, provided, as is practically always the case, that the number of units (pounds, yards, etc) in each lot is known The processing cost will always be $5 per 100 units

Time Not Utilized —There is, however, one aspect of the time question that still remains a very important feature If the process or any one of the delivery points has not worked continuously during working hours, then each of the hours will not have provided its full tale of 100 units On the day's output there will be a shortage of the full number of units This shortage will be proportional to time wasted, so that even in this instance it is not absolutely necessary to take account of processing time, inasmuch as the loss of output can be translated into lost hours by a simple calculation, thus

Total output per day of 8 hr		800 units
Actual output		700 units
Shortage of output		100 units
Rate of output, 100 per hour	Time lost, 1 hr	Value, $5

In practice, however, wherever possible, the actual running time of processes, which may be worth several dollars per hour in process rate, should be checked by some form of mechanical recorder, which will yield the whole story of all stoppages as well as the total amount of them

Jobs with Variable Processing Time —When the time of processing is not invariable, but some materials take a longer time to process than others, then the time of each such job or lot should be recorded in the usual way The only exception to this rule will be in the case where the behavior of each kind of material is perfectly well known, that is to say, that the actual speed on each variety is practically a fixed amount In general, however, when several different kinds of material are processed,

the variations will not be so much under control as in the case of a single uniform material In other words, the speed of processing will itself be liable to vary from job to job for the same unit quantity

It is therefore better, where the speed of processing is variable, to record the time taken on each job or lot This time multiplied by the process rate will give the process cost of the lot

In the same way time lost or not utilized will be the difference between the total time charged to lots or jobs and the total working hours of the day, provided, of course, that the time of individual jobs has been *correctly* recorded, and that wasted time has not been charged up to a job or jobs illegitimately The only remedy for this kind of indiscretion is the mechanical recorder whose record can be compared at the end of the day with the actual tale of jobs as recorded on time sheets

Process-rate Schedules —The calculation of process rates is at its simplest in the case of single-type departments Figure 75 represents a blank suitable for this calculation The annual values of each service factor are transferred from the service-factor schedules as exhibited in former chapters Total of all such service factors represents the annual cost of the manufacturing capacity of the department

(1) *Single Delivery Point* —This manufacturing capacity may be that of a single delivery point If so, then the above total divided by the standard working hours per annum of the department will give an hourly amount which will be the standard process rate for the department

(2) *Several Delivery Points* —If the department is of the single-parallel (Fig 50B) type or the single-feeder-parallel (Fig 50C) type, then there will be more than one delivery point, each of which requires a process rate In this case the general departmental process rate obtained, as just described, will be *divided* by the number of delivery points Or, what is the same thing, the annual cost of service factors may be divided by the number of delivery points, giving the *annual* cost for the manufacturing capacity of *one* delivery point, and this latter amount again divided by standard working hours Either method gives the standard process-hour rate for one delivery point From what has already been said as to this type of department, it will be remembered that all delivery points must necessarily have the same process rate, the processes being all identical and, therefore,

making precisely identical call on the services represented by service factors

Inclusion of Operative Labor in Process Rate —In this type of department it is very often the case that operative labor works in groups and its work is scattered over various stages of the process in an irregular way Under such circumstances there is no reason why this operative labor should be treated any different from other services On the other hand, certain advantages of simplicity are obtained by consolidating such direct labor with process cost

To do this, another line is added to the process rate schedule, which will read

Annual cost of operative service

The amount of operative wages expended in standard working hours during the year will be set opposite this line and added into the "total annual cost of all service factors" It thus becomes a component of the process rate, and to distinguish this type of process rate from the ordinary type which does not include operative labor, it may be termed and referred to as a *consolidated process rate*

Where the consolidated rate is in use, the payroll cost of operative labor in the department must be charged to the departmental burden account

Conclusion —It has been seen from the foregoing that the upbuilding of process rates for a single-type department is conducted in two or three stages

1 The aggregate total of all service factors which are chargeable to the department (and which form the cost of its annual manufacturing capacity) is ascertained on the blank (Fig 75)

2 This annual total is divided by the standard working hours, if there is only one delivery point, and the result is the hourly process rate for the department delivery point

2*a* Or, the annual total is divided by the number of delivery points, thus finding the annual cost of the manufacturing capacity of one delivery point, and then

3 The annual cost of the manufacturing capacity of one delivery point divided by the standard annual working hours gives the hourly process rate for *one* delivery point

If operative labor is charged to the departmental burden account it can be treated, usually, on the same footing as other

service Its annual cost may be added into the grand total of annual cost of manufacturing capacity, and the resulting process rate is the *inclusive* cost of processing, there being no other elements of cost to be considered (except direct material, if any) Such a rate is called a *consolidated* process rate

Process Rate Department ----- ----	
Space Factor	
Power Factor	
Storage-transp't Factor	
Supervision Factor	
Organization Factor	
Prod Equipm't Factor	
Special Factor (if any)	
Operative Labor (if included)	
Total Annual Factor	

Standard Hours	No of D'ly Points	Process Rate

Fig 75

The results of a day's, or month's working of the department will be

1 So many dollars charged into cost of jobs through process rates

2 So many dollars wasted, owing to failure to utilize all of the manufacturing capacity that has been provided This amount will appear as a balance in burden account and is chargeable to profit and loss

CHAPTER XXXIII

BUILDING THE PROCESS RATE

II PLURAL-TYPE DEPARTMENTS

Plural-type departments differ from those of single type in that processes within the department, each with its own delivery point, are independent of each other and not alike As long as it is the *same* process, it does not matter how many identical machines with delivery points there are in a single-type department, since each one is the exact duplicate of the other, and, therefore, the cost of manufacturing capacity of the department is divided *equally* between them In other words, they all have the same process rate

Processes Not Identical —When, however, the processes included in a department are not identical, it will generally happen that a different rate results for each delivery point, although sometimes there may be two or more groups of processes each with several delivery points In this last case all the delivery points in one group will have the same rate, but these rates will differ from group to group These two varieties of plural-type department are called, respectively, the "plural-ultimate type" (*cf* diagram E, Fig 50) and the "plural-group type" (*cf* diagram D, Fig 50)

Costing as Affected by Type —Both of these varieties of the plural department demand the same arrangement of process

Process no	1	2	3	4	5	6	7	8	9	10
Hourly rate	$1 50	$2 45		$6 00		$3 25	$1 60	$2 30	$4 80	
			$2 00	$2 00	$2 00				$2 40	$2 40

FIG 76 —Plural type department with groups

rates, except that in the case of groups a rate is first found for the whole group and this rate subsequently divided equally among the delivery points in the group

Figure 76 exhibits this arrangement. In a given department, there are supposed to be ten processes, 3, 4 and 5 are identical, and also 9 and 10. All of the others are different from each other and, of course, from either of the groups. In the case of 3, 4 and 5, the rate for the whole group is found to be $6, and as there are three delivery points in this group, the rate for each point is $2. In the case of 9 and 10, the rate for the group is $4.80 and for each delivery point $2.40. All of the other processes have their own individual rates.

Subdepartmentalization.—It will be seen, when the steps required for building up process rates in a plural-type department are described, that what is done is virtually to carry departmentalization one stage further than is necessary with single-type departments. Having assembled all of the costs of the manufacturing capacity of the whole department, it is necessary to consider each process (or group), as a subdepartment and to distribute the annual cost of each factor in such a manner that each process gets charged with its proper share of such factor. While this is a purely mechanical operation, and one which with modern electric calculating machines can be carried out expeditiously, still it must be said that recasting of rates is a more onerous proceeding than in the case of single-type departments. Whenever, therefore, it is possible to make processes and departments coincide exactly, simplicity of cost methods results.

Basis of Subdepartmentalization.—In every case where an amount has to be prorated or distributed over others, some basis is either recognized or implied. In distributing the annual cost of each service factor which has been charged to the department among the various processes in a plural-type department, much the same bases are used as in the case of making the original distribution to departments, as discussed in Chaps. XXII to XXVIII. Thus, the space factor will obviously have to be prorated among processes according to the space occupied by each. The power factor will be prorated according to the amount of power used by each process, and so on. More detailed discussion of this distribution will be given presently. It is sufficient to point out here that *no new principle* is involved. Having distributed annual cost of services to departments, we now, in the case of plural-type departments, go on to a further distribution to processes along precisely the same lines.

Process-rate Schedule for Plural Type—In Figure 77 a blank is presented which will serve for the building up of individual process rates in a plural-type department In the upper portion of the blank the cost of service chargeable to the department is collected, factor by factor, and in the lower portion these amounts are subdepartmentalized, or allocated, to the various processes, according to the call of each on the particular service When all of the service factors have thus been allocated to processes, cross-totalling gives a total against each process, which is *the annual cost of the manufacturing capacity of that process* This annual amount, divided by the standard annual working hours, gives the *standard hourly process rate*

The way in which the allocation to individual processes is made will now be discussed, factor by factor

1 *Space Factor*—In distributing space factor to the processes in the department, a plan should be prepared showing the working space required by each machine, and that devoted to passageways, etc When all the space thus legitimately assignable is allocated, there may sometimes remain a portion of unoccupied or unutilized space, which perhaps has been reversed for extensions, or is simply surplus space for which no use can be found This condition, namely, non-utilization of the factor service on *any* process is peculiar to space factor, none of the other factors chargeable to the department containing any amount not utilized for process work

The disposal of this item presents no difficulty It is entered on a line by itself (see Fig 77) and, as the value of it is not represented in any process rate, it follows that this value will find its way ultimately to profit and loss, inasmuch as it will be charged into departmental burden account, but there will be no corresponding credit from any cost sheet This is perfectly in order As long as the space remains unutilized, it is a loss The fact that it is inside a department makes no difference in this respect It is exactly the same as if, instead of being inside a department, it were a separate small building standing idle by itself An idle space is a loss, wherever it happens to be

Should additional processes presently be installed, then this space charge would, of course, be charged up to the new process and would cease to enter the unutilized category

Bearing in mind the disposition of unutilized space, the allocation of the remainder of the annual factor expense to processes

Process Rates Effective —19 Dept —

Standard Annual Hours	Annual service factor charges to department							Hrly dept rate[1]
	Space	Power	Storage trans	Suptce	Orgn	Prod eqt	Total	
	Sq ft	Kw						
	$	$	$	$	$	$	$	

Annual service factor charge to individual process

Process No	Space		Power		Storage trans	Suptce	Orgn	Prod eqt	Total	Pro rate
	S F	$	Kw	$						
101	n	$	n	$	$	$	$	$	$ $	1 50
102	n	$	n	$	$	$	$	$	$	2 40
103										2 00
104	n	$	n	$	$	$	$	$	$	2 00
105										2 00
106	n	$	n	$	$	$	$	$	$	3 25
107	n	$	n	$	$	$	$	$	$	1 60
108	n	$	n	$	$	$	$	$	$	2 30
109										2 40
110	n	$	n	$	$	$	$	$	$	2 40
111	n	$	n	$	$	$	$	$	$	1 20
112	n	$	n	$	$	$	$	$	$	3 10
Unused	n									
Total	n	$	n	$	$	$	$	$	$	

[1] Hourly department rate This rate (total annual hours divided into total cost of annual service) is of no value for cost purposes, but serves to rank the department with other departments

Agreements —(1) Total of annual charge to each factor must agree with distribution at foot of sheet (2) Total of all annual charges to department must agree with grand total of all charges to processes, including unused space (3) Total of all hourly rates multiplied by standard working hours, added to value of unused space must agree with total annual charge to department

FIG 77 —Process rate assembly, plural type department

is very simple The total charge to the department will be found on the space distribution schedule (Fig 62*a*), and this amount divided by the floor space of the department gives the rate per square foot The working space occupied by each machine is found from the plan and set opposite each process number Multiplying process space by the space rate gives the charge against each process, which is set in the space column

2 *Power Factor* —Assuming that power is taken in the form of electric current only, a single column suffices for the allotment of power charge to processes If other forms of power, such as live steam or compressed air, are also used, additional power columns will be necessary, one for each service

Opposite the number of each process will be placed the annual consumption of current based on standard working hours The rate per kilowatt being found from the power-factor schedule (Chap XXIV) multiplication of each process' consumption by this rate gives the annual power charge for each process

3 *Storage-transport Factor* —Charges to the department will be entered up from the storage-transport schedule total (Fig 68) Distribution to processes may have already been carried out on that schedule (*cf* Dept B Fig 68), but, if there are many processes in one department, it may be more convenient to make the distribution on this schedule

If already performed on Fig 68, the entries will only require copying here, but if not, then the distribution here must be carried out on the lines explained in Chap XXV in connection with Fig 68

4 *Supervision Factor* —The figures against each process for supervision factor will be found in the supervision-factor schedule (Fig 70) and only need transferring here But in the case of departments with many processes, it may be more convenient to make the distribution calculations on this blank, in which case they will be carried out in precisely the same manner as described in connection with Fig 70 Choice between the two methods is wholly a matter of the convenience of size of working sheets Where departments do not contain many machines, it is more convenient to work out all of these allocations on the distribution schedules themselves, as is done in the case of single-type departments Only when such a practice would lead to an unwieldly sheet is it necessary to do the actual calculation here

5 *Organization Factor*.—The above remarks apply in equal degree to organization factor, which is treated exactly like supervision factor in regard to the carrying out of the calculations. For preference it is effected on Fig. 71, the organization distribution schedule, but if space compels, it is carried out here.

6 *Productive-equipment Factor*.—Figure 72 is the factor-distribution schedule for this factor, and calculations are made there if possible. Otherwise here on the lines described in Chap. XXVIII.

7 *Total*.—When all of the factor columns have received their entries, either from the original figures in the factor schedules or worked out on this sheet, the whole of the annual charges against processes will have been collected. Cross-totalling of the figures opposite each process number will furnish the annual charge for all factor service against that process on the standard working hours basis. If, therefore, each such total is divided by the standard working hours, the *hourly process rate* results.

Certain agreements, as indicated on Fig. 77, should be made, and as soon as these are verified, the whole of the standard hour rates for the department will be available for use.

Inclusion of Direct Wages in Process Rate.—The advantages of making a consolidated process rate (including the hourly charge and for direct labor in one total) are not so marked as in the case of single-type departments. The matter was discussed at length in Chap. XIX, but it may be briefly stated here that when wages associated with each process are standardized and fixed, then some clerical work is saved by having a single rate to deal with instead of two.

Conclusion.—When the figuring on the process-hour schedule for plural-type departments has been carried out as discussed in this chapter, the result will be a virtual subdepartmentalization, which endows each process, for costing purposes, with the status of a department. Each process becomes entirely independent of all others in the department, may be busy or idle, without others being affected.

As the process rate represents the hourly cost of the manufacturing *capacity* of the process, it is obvious that it will be discharged, either on to jobs, or, alternatively, into the pool of waste. The charge to waste will, therefore, be in proportion to the value of the process hour less general economies effected by the department when on short time. In other words, as far as

costs of production are concerned, the effect of the subdepartmentalization is a complete isolation of the process Its rate of production and its rate of idleness will be summed up separately, with as complete independence of neighboring processes as though it were a single-type department all by itself

Nevertheless, as alteration in a factor will necessitate the recasting of all processes in a plural-type department, from the point of view of economy the productive equipment should be, as far as is practicable, divided up into single-type departments The costing in these is *no more accurate* but it is *simpler*

PART IV

THE CONTROL OF STANDARDIZED OVERHEAD

CHAPTER XXXIV

NATURE OF THE CONTROL PROBLEM

Successful connection of overhead with the cost of jobs or units of product depends on adequate recognition of the principle that has been developed in the foregoing chapters, namely, that overhead is expenditure incurred for the maintenance of the plant in a state of preparedness to do process work, or, in other words, that it is the cost of a definite amount of manufacturing capacity

It will be obvious that before we can speak of the cost of manufacturing capacity, or of the cost of a particular service as ministering to a given amount of capacity, we must have a clear and definite idea of what this capacity really is Having settled this, the next consideration is the amount of service which is *properly associated* with the given capacity In other words, we have here two standardized quantities, one of which is the cost of the other

Bases of Capacity and of Service —Manufacturing capacity has been shown to be based on a standard number of working hours during a period, such as a year The cost of this capacity is based on the total cost of certain services (factors) when the standard capacity is being fully utilized Any departure from this relationship is necessarily a less efficient utilization of service, but this relationship may be subject to variation from time to time, owing to various causes, which may be enumerated as follows

Possible Variations from Standard —Variations from standard may take three principal directions

1 Capacity itself may vary, as in the case of unexpected overtime or short time, not foreseen when budgets were made up

2 The current cost of any or all services may vary from standard for three reasons, *viz*

a For the same capacity, additional and unforeseen service (additional to that allowed for in budgets) may be coming through in the current accounts

b The rates of wages of employees giving service (in any of the service factors) may have increased or diminished

c The cost price of such material as is used in connection with factor service may have risen or fallen

3 Manufacturing capacity may have been wasted The services provided may be precisely those required to maintain full or standard capacity, but these services may not have been utilized to the full, owing to idle machines In this case the unutilized service has dripped into the pool of waste instead of becoming charged into costs of jobs through process rates

Any or all of these influences tending to change standardization may operate singly or all together They may tend to cancel out or to reinforce each other

Problem of Control Defined —The problem of control consists in so observing these variations *and their causes*, that, on the one hand, if such variations are unjustifiable, they may be stopped at the earliest moment, and, on the other hand, if they are reasonable and also permanent, steps must be taken to modify standardization, since it is evident that *new conditions have developed* since standardization was made But unless these variations, if permanent and justifiable, are, in net effect, sufficient to sensibly affect process rates, new standardization is not necessary

Departmentalization —These controls will be exercised on the departmental figures, since conditions may vary in one department quite independently of another Moreover, as each department has a burden account to which all process costs charged to jobs form the credit and all overhead charged to the department forms a debit, there is ready to hand a definite result arising out of the ordinary course of business by which to determine how far process rates are actually distributing both legitimate and illegitimate charges to overhead The disposal of balances left in burden account will depend upon what has happened in regard to standardization, that is, their significance depends upon what has actually taken place in the way of variations

Divisions of the Control Method.—It is convenient to consider control in different stages, namely:

1. Variations in capacity. Actual time differing from standard time.

2. Variations in annual charges to each factor. In general, this class is less liable to vary than others, as will be explained later.

3. Variations in intermittent expenditures. These are controlled differently from the others, and the effect of variations, unless in special circumstances, is more properly carried forward to another year than permitted to enter costs.

4. Variations in the cost of hourly wage items, or in cost of material *entering service factors*. The variations from these causes are the most usual and need the closest attention to hold to standard.

5. Variations in the amount of capacity utilized. Unutilized capacity has, of course, no remedy. All that has to be done is to ascertain why it has occurred and ascertain the monetary value of the waste thereby incurred.

These different stages of control will be dealt with in the ensuing chapters.

CHAPTER XXXV

CONTROL OF THE TIME BASIS

The total expenditure on overhead during a year is the price paid for the manufacturing capacity of the plant The relations of this expenditure with production can be either accidental or standardized Under the older methods of accounting, the number of hours that *happened* to be worked in a given period was set against the number of dollars that happened to be expended, and when these dollars were plastered in a uniform layer over the jobs that happened to be done in the given hours, overhead was considered to be satisfactorily disposed of

Modern View of the Time Basis—This easy-going method can no longer be considered as abreast of the progress that has been made in other productive activities Taking into consideration the necessarily *recurrent* nature of expenditure for the maintenance of processes, it is evident that one hour's work of a given process this week should cost the same as one hour's work next month or six months hence, unless, of course, the bases of such cost (rates of wages, prices of indirect material, scale of salaries, etc) have risen or fallen in the meantime

Standardizing overhead expenditures means, therefore, that the cost of an hour's work (*i e*, of work for a given *time*) of a given process is calculated when such process is working under normal conditions Utilized manufacturing capacity will then be at its maximum, because under those conditions *all the services comprised in overhead will be fully employed and absorbed by processes* Any departure from these conditions means that a portion of the services provided are not being usefully absorbed but are going to waste In addition to actual process work which is being done, there will be process work which is not being done, although services are being maintained and paid for to enable it to be done Relations between time and overhead are thus established

Approach to Standardization—When a plant is set up and set going, a certain scale of operations is necessarily implied The

interest, depreciation, insurance, taxes, etc., which will be incurred depends upon the value and extent of the equipment. The salaries paid are in proportion to the expected volume of production. The indirect labor engaged will have relation to the amount of service which the expected volume of production demands. Whether it is realized or not, an elementary degree of standardization is always implied in making these arrangements.

The *time* during which all of these activities will operate also receives, necessarily, considerable attention. Shall we have a 45-, 48-, 50- or 54-hr week? Shall we work on Sundays? Shall we employ single, double, or twenty-four hour shifts? Questions like these are, however, approaches to standardization of time, however incompletely so. When they have been determined, the completion of standardization is no very difficult task. But until this further step is taken, the relations between the expenditures enumerated in the last paragraph and the amount of product realized by using these expenditures to maintain processes through an undefined number of hours will remain indefinite and vague. Such relations cannot be precise and can be expressed only by ratios, which, however, mean nothing more definite than the indefinite relations on which they are based. Ratios cannot put significance into relations which are not in themselves significant.

Standardization of Time.—If, however, we take the necessary further step, the situation is clarified. Having settled on a 48-hr week, the next step is to ascertain just what this means in terms of monthly and annual time. In certain weeks, owing to public or local holidays, less than 48 hr will be worked. In some months there will be more working days than in others. By taking a calendar on which all such interruptions are marked and setting the actual hours for each day (Saturdays being shorter) against each working day, totals for the whole year and for each month are accurately determined.

This, however, in some industries, will not be sufficient. It may be known that during certain weeks overtime will be regularly worked so many hours a day. In other portions of the year short time will be worked, Saturday being perhaps cut out for several weeks. These facts are to be taken into the record, so that the final result is a close approximation to the actual number of hours, during which, in the absence of unforeseen unfavorable conditions, the plant will be at work.

As all departments do not necessarily work the same number of hours, determination of standard hours will be made for each department and not for the plant as a whole

The result of this calculation will be that we shall have a very definite idea of what we are preparing to do We shall know with considerable precision on how many hours of productive capacity in each department we are basing our expenditure, and we shall know this not only as an annual total but also just how this manufacturing capacity is distributed among the twelve months of the year

Calendar —Figure 78 shows a form of calendar which may be used for calculating standard working time The figures in this example are based on a 50 hr week in the year 1929 Each full day is assumed to be 9 hr and each Saturday 5 hr

In making up such a calendar, the number of Saturdays in each month is first taken out and entered as shown Then the remaining week days (less any public holidays or other known interruptions) are entered below Each Saturday is multiplied by 5 and each other day by 9, the results being entered in the third (hours) column Addition of the two items gives the total working hours for the month, which total is entered in the fourth column

Next must be considered the exceptional conditions which are likely to occur during the year to increase or reduce working hours, as indicated by the calendar In the example, the practice of the plant to close down on Saturdays during July and August is shown Further, the expectation of overtime working in November and December is also taken care of, as shown The last column incorporates these modifications in the monthly totals, with the result that a standard working year of 2,503 hr results

One such calendar is made out for each department, because the working hours of departments very often differ from one another in some degree If each department is dealt with on its own merits, departures from standard do not affect more than the departments in which they occur If, on the other hand, it is attempted to set up a standard calendar for the whole plant and consider it standard for all departments, local variations are more likely to prove disturbing influences

Use of Standard Time —The use of this calendar, which records the standardized time during which we have to provide

the services which give rise to manufacturing capacity, will now be considered It may be supposed that the working year is found to contain 2,503 hr The problem is to find the cost of 1 hr

Months	Number of Saturdays and full days	Working hours	Total hp in month	Add over-time hours	Deduct short-time hours	Standard working hours
Jan	Sat 4 Full 21	20 189	209			209
Feb	Sat 4 Full 18	20 162	182			182
Mar	Sat 5 Full 21	25 189	214			214
Apr	Sat 4 Full 22	20 198	218			218
May	Sat 4 Full 22	20 198	218			218
June	Sat 5 Full 20	25 180	205			205
July	Sat 4 Full 22	20 198	218		20	198
Aug	Sat 5 Full 22	25 198	223		25	198
Sept	Sat 4 Full 20	20 180	200			200
Oct	Sat 4 Full 23	20 207	227			227
Nov	Sat 5 Full 19	25 171	196	18		214
Dec	Sat 4 Full 20	20 180	200	20		220
Year	Sat 52 Full 250	260 2,250	2,510	38	45	2,503

NOTE —Based on 50 hr week, less principal public holidays, with some overtime in winter and closed down Saturdays in summer

FIG 78 —Calendar for 1929

It has been shown in previous chapters that the cost of a service is made up of two varieties of overhead expenditure One of these is divisible by the annual hours and the other is a

multiple of the annual hours Items like interest, depreciation, salaries, etc , are divisible by the standard hours, but items like indirect labor, power cost, etc , are proportional to working hours The former variety is easily ascertained and its division by hours presents no problem The latter, however, must be carefully built up by observation of the plant during a condition of normal working We shall then be able to observe *just what expenditures of an hourly character are normally necessary* to full running of each process, and the annual total of these is, of course, found by multiplying them into standard hours The final result is the standard cost of a service for one year for a given department and for a standard number of working hours

It will be evident from the foregoing that *the determination of standard working hours is antecedent to all calculation of service factors* It is, in fact, the foundation upon which all rests Unless we know what number of working hours we expect in the year, we cannot speak with any precision of our manufacturing capacity, and, consequently, cannot ascertain its cost

Standard Time and Service Factors —The way in which service factors are built up on the basis of standard time has been already dealt with in full (Part III) Nothing further need, therefore, be said here as to the use of standard time for this purpose We may proceed to the consideration of its use in relation to the control of standardization in general

Standard Time and Departmental Time —If the calendar has been compiled with reasonable care and accuracy, and if no abnormal conditions develop, then standard time and the time actually worked by the department will be identical

But some definition is necessary as to what is meant by "departmental time" In this connection the expression refers to the *period between the official starting and stopping hours of the department* This is very often a different matter from the total number of process hours worked in the department It represents what *should* be worked, *i e*, the maximum capacity, under the given conditions Thus, of the standard and official hours of the department on a given day are 9, and if there are, say, 6 processes, then the total process hours are 6×9 or 54 But if some of the processes have failed to work full time, only a total of, say, 50 hr will have been made This failure does not affect the standard or official day, which remains 9 hr

When we speak of the "standard" hours of the department, therefore, it is the calendar hours we refer to When we speak of the official departmental hours, it is the total hours worked, which are the same as standard, *unless* new conditions have been set up (overtime or short time) If, owing to overtime, the official department hours have been increased to 10, or if by reason of slackness the working day has been reduced to 7, then standard and official department hours will no longer coincide, and this must be made a matter of record

Comparison of Standard and Departmental Time —Figure 79 shows a blank for control of standard and departmental time

Control of Standard Hours					Dept
Month	Standard		Departmental		Remarks
	Month	Cumu	Month	Cumu	
Jan	209		209		
Feb	182	391	182	391	
Mar	214	605	230	621	16 hr overtime
Apr	218	823	218	839	
May	218	1 041	218	1,057	
June	205	1,246	205	1,262	
July	198	1,444	198	1,460	
Aug	198	1,642	198	1,658	
Sept	200	1,842	200	1,858	
Oct	227	2,069	211	2,069	16 hr short time
Nov	214	2,283	214	2,283	
Dec	220	2,503	220	2,503	
Year	2,503		2,503		

FIG 79 —Comparison of standard and departmental hours

The standard hours for each month are entered in advance for the whole year, and each month's departmental time, as ascertained by record of the starting and stopping hours of the department for each day, is set against the standard figure Only in case of *unexpected* overtime or short-time working should there be any difference between the figures in the two columns One set of columns is devoted to *cumulative* entries, so that discrepancy *to date* may be observed at all times This last is really the significant matter If a discrepancy shows signs of increasing, either new conditions have been developed or the original standardization was in error In either case revision is indicated

Chart Control of Standard and Department Time —The use of a graphic representation in this connection is advisable Figure 80 exhibits the figures tabulated in Fig 79 It will be observed that the year passed with only two departures from standard In March unexpected overtime of 16 hr was worked In October the short-time season was felt earlier than usual and 16 hr were cut down in that month unexpectedly The result of the two exceptional conditions was to cancel out, so that to the end of November 2,283 hr had been worked and this was the amount called for by the standard calendar

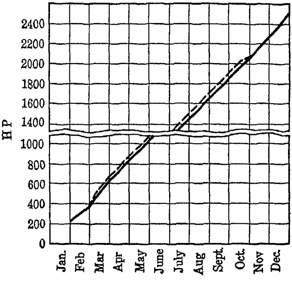


Fig 80

The dotted line, representing the exceptional condition, is seen to run parallel with the standard hour line, thus implying that conditions are not diverging from normal Should the two lines tend to separate, this would indicate that standards were being superseded by new and abnormal conditions Under such circumstances, inquiry would be necessary, and if, for example, the divergence was due to the beginning of a contemplated long spell of overtime, new rates might possibly be required (*cf* Chap XIV)

Single-type Departments with One Delivery Point —It was pointed out above that even when departmental time varies from

standard, such variation will not explain, and has nothing to do with, the total of process hours which may have been worked Any total of departmental hours, whether it coincides with standard or not, provides its own maximum of *possible* process hours, but it does not follow that all of these process hours will have been worked An example was given above, showing process hours 50, when the length of the official departmental day would have admitted of 54

But in the case of a single-type department with only one delivery point, the two sets of figures would seem necessarily to coincide If a department officially works 8 hr , its delivery point must work 8 hr to all appearance This, however, is not true in practice It might happen that without any official instructions to work short time, a breakdown reduced the actual process hours to 6 The *intention* to utilize the full capacity of the department for 8 hr in conformity with prearranged standard would still hold good, but actual performance fell short In this case there would be 6 hr charged to jobs and 2 hr wasted in the department If expenses were reduced during the stoppage that would be a credit against the waste

Alteration of Standard an Administrative Act—This brings us to a definition of what constitutes a departure from standard time as prearranged It must be a deliberate administrative act It must be the result of a deliberate order signifying a change of policy to that extent If a single-type department with only one delivery point is instructed to work only 6 hr , then its official department time is 6 hr , and this must be set against standard time on Fig 79 and on the charts But if no such order has been given, that is, if there has been no change in policy and, therefore, no change in conditions, the fact that the single-delivery point failed to work the full 8 hr is a misfortune that can only be considered as involving waste

In practice, of course, overtime or slack time is rarely confined to a single day, especially the latter In dealing with the records of a whole month, therefore, failure of a single-delivery point to deliver 100 per cent, (that is, if it delivered 198 instead of a standard 220) in a given month, *no short-time instructions having been issued,* it is easy to perceive that we are dealing here with a case of unutilized capacity and not with discrepancy between standard and official departmental hours

The case of the single-delivery point in a department is the only one likely to give rise to any uncertainty, and it has, therefore, been discussed somewhat fully In all departments with several delivery points, the official working hours of the department are clearly seen to be a wholly separate quantity from the number of hours that any individual process has happened to work As long as it is remembered that *standard hours must agree with official department hours* and have nothing to do with any aggregate of process hours which may have been worked during these official department hours, no ambiguity can arise

Basis of Standardization—If standard time, as settled by calendar, and official department time, as actually worked, are so controlled that divergence is immediately observed, and, if necessary, steps taken for recasting standards, then the control of time is completely established This is true because process hours are themselves only a subdivision of department time If that increases, there are proportionately more process hours and *vice versa* It is not necessary, therefore, to control process hours in relation to standard time, although it remains necessary to do so from the viewpoint of wasted manufacturing capacity The basis of standardization is department time, and standard time must be kept closely adjusted to that But it must be remembered that standard time only needs recasting if new permanent conditions arise Occasional overtime or short time do not disturb the situation But a long spell of either is really equivalent to a new condition being set up and the whole situation should then be reviewed (*cf* Chaps XIII and XIV)

Control of Process Hours—Having thus established a method of controlling agreement between standard working hours, as budgeted, and departmental hours as actually worked (it being understood that these two must agree unless (1) an error in the calendar has been made, or (2) unexpected overtime or short time, not foreseen when making up the calender, has been ordered), we have now to consider the differences that may arise between departmental hours and those worked by individual processes in the department

Figure 81 presents a form which may be used for this control In the first two columns the monthly record of departmental hours is entered, month by month These hours are then multiplied by the number of processes (*i e*, of delivery points) in the department The type of department does not influence

this calculation. Whether the delivery points are all alike or belong to entirely different processes makes no difference. The resulting figure is the maximum number of hours of processing that are possible each month.

In the fourth column the actual processing hours as obtained from the machine records at each delivery point are entered. Subtracting from the previous column, we get the total of unutilized capacity hours for the month. In the final column this total is carried forward cumulatively, so that the total of unutilized capacity hours *to date* are shown each month.

Use of Process-hour Control.—This record is only of value in the form given when it refers to single-type departments wherein

Unutilized Capacity ——————————Dept.

Month	Dept Hrs	Process Hours		Hours not Utilized	Cumu.
		Maximum	Actual		
Jan	209	* 1254	1250	4	—
Feb	182	1092	1086	6	10
Mar	230	1380	1369	11	21
Apl	218	1308	1300	8	29
May	218	1308	1299	9	38
Oct	211	1266	1260	6	82
Nov	196	1176	1171	5	87
Dec	200	1200	1189	11	98
Year	2510	15 060	14 962	98	—

FIG. 81.

the value of a process hour is the same for all delivery points. In such cases the unutilized hours assist in explaining the figures in burden account, namely, balances left undistributed at the month end. Under full-time conditions Fig. 81 shows how much should be expected to remain in burden account by reason of idleness of processes. If the process rate is, for example, \$2 per hour per delivery point, and 6 hr. are shown as unutilized, then \$2 × 6, or \$12 would be expected to appear in burden account as undistributed balance. But in the case of plural-type departments, wherein several different process rates are to be met, this simple arrangement is insufficient and requires expanding so that the value of the idle time at each separate rate can be aggregated. This will be dealt with later.

Figure 81 has been introduced here to clinch the point that process hours are necessarily proportional to official department hours, and that, on the other hand, failure to utilize all of these hours is a different matter which has nothing to do with the question of standardization at all If the relation between standard (calendar) hours and official department hours is controlled, the further relation of process hours to either becomes purely automatic

Conclusion —The principal points to be observed in regard to the standardization of time are that

Standard (calendar) hours Actual departmental hours	will differ only when new and unexpected conditions arise
Actual department hours multiplied by number of processes Actual total of process hours	will differ by the number of idle process hours

As time standardization is the basis of the whole method of service factors and process rates, close observation should be made of all divergences If the calendar has been set up with reasonable care and foresight, standard and actual departmental hours should agree, except where new orders for overtime or short time have been issued If these are temporary, standards need not be altered (*cf* Chaps XIII and XIV), but if permanent, or expected to last for considerable time, then new conditions are brought into play which will require that standardization be reviewed

On the other hand, the manufacturing capacity of a department is proportionate to the period included between its times of starting and stopping The individual processes are only subdivisions of this capacity Consequently, their maximum capacity depends on the department's working hours But their utilized capacity is an another matter altogether, which must be made the subject of a separate record, as indicated above

CHAPTER XXXVI

CONTROL OF EXPENDITURES

I INTERMITTENT EXPENDITURES

The subject of control of expenditures is most conveniently approached by dealing first with the treatment of intermittent expenditures, since these are obviously irregular in their incidence, and are not, apparently, subject to the general principle that legitimate expenditure (overhead) is of recurrent nature

Intermittence and Recurrence —It was explained in Chap XVI that the intermittent character of charges like heating and lighting, which apply only to winter months, and repairs, which have no relation to productive activity except in the broadest sense, could be so handled that each month absorbed its fair share in proportion to working hours The *intermittent* character of the items was transformed into *recurrence*, so that each hour received an equal share of the year's total

There would be no justification for treating these items in the way suggested if it were not that their intermittent character is only an apparent one An item which came up only once in a long series of years could hardly be classed as legitimate overhead Thus, loss incurred by the bursting of a boiler or a flywheel, which is unforeseeable and cannot be expected to be recurrent, would not be a legitimate item of overhead But such matters as lighting and repairs are intermittent *only as regards particular months* In a series of years[1] they are not intermittent, but fairly constant, that is, their amount will vary somewhat from one year to another, owing to changes in prices, wages, etc , but for the same manufacturing capacity the cost per annum will vary but little from one year to the next Thus, regarded as annual expenditures, they are not intermittent, but as regards monthly

[1] It may be asked why a year is to be considered as a more important or significant unit than a month The answer is that a year is a division of time established by nature The cycle of seasons is itself a recurrent cycle, even though the distribution of temperature, rain, etc is not *identically* repeated in each year

installments and, more particularly, as regards hourly incidence, they are very irregular and intermittent

First Step Equalization.—In order to exhibit the working of the control of intermittent expenditures, the subject of repairs and maintenance will be taken as an example, for the reason that this is not only one of the most important but also one of the most difficult cases of intermittence likely to be met

Figure 82 presents a form which serves to list the expected items of expenditure on repairs and maintenance in one department, month by month Each month's total is brought out

Space Factor Budgetted Expenditure				——————— Dept Repairs & Maintenance		
Month	Item	Labor $	M'tl $	Total $	Month Total	Cumu Total
Jan	Reprs on Bldg	10	3	13-		
	" Heat Eqpt	3	1	4		
	" Light Eqpt	2	13	15	32 00	32 00
May	Reprs on Bldg	240	96	336		
	" Heat Eqpt	—	—	—	336 00	464 00
	" Light Eqpt	—	—	—		
Dec	Reprs on Bldg	25	10	35		
	" Heat Eqpt.	2	6	8		
	" Light Eqpt	4	15	19		
					62 00	750 00
Total	For 2503 hours	600	150	750	750 00	—

FIG 82

separately and in an additional column this total is made cumulative, so that the expected total to date is always known The monthly amounts in this budget will, in general, vary greatly from month to month Outside repairs, painting, etc , will be carried on in the warmer months In the example, January stands at $32, May at $336 and December $62 Obviously, these amounts have no relation to the degree of manufacturing activity which takes place in the same months The first step, therefore, is to equalize the charges to production, so that each working hour gets an equal share of the annual total of expenditure

This is effected by means of a blank like Fig 82*a* Each month, with its standard working hours listed, an annual total of 2,503 hr, the annual cost of repairs and maintenance, taken from Fig 82, is then prorated over months in proportion to the number of standard working hours in each A cumulative total, showing amount thus charged into departmental burden to date, is also provided The amounts against each month, *e g*, $62 63 in January, $65 33 in May and $65 83 in December are the *standard* charges to the space factor on account of repairs and

Budgeted total for year prorated over working hours			
Month	Std hrs		Cumu
Jan	209	$ 62 63	
Feb	182	54 54	$117 17
Mar	214	64 13	181 30
Apr	218	65 33	246 63
May	218	65 33	311 96
June	205	61 43	373 39
July	198	59 34	432 73
Aug	198	59 34	492 07
Sept	200	59 94	552 01
Oct	227	68 03	620 04
Nov	214	64 13	684 12
Dec	220	65 83	750 00
Total	2,503	$750 00	

Fig 82*a* —Total of Fig 82 for the year ($750) prorated over standard working hours

maintenance It will be noticed that none of these has any correspondence with the budgeted amounts for the same month

Control of Budgeted and Actual Expenditure —It is evident, therefore, that a comparison of actual expenditure with standard charges would be of no service whatever for control purposes The standard charges are a rearrangement of budgeted charges on a different time basis In the budget they are distributed through the year as they will probably occur In the standard charges (Fig 82*a*) they are distributed throughout the working year evenly, so that each working hour bears an equal amount of the annual total To check the accuracy of the budgeting and, therefore, of the standardization, we must compare actual or current expenditure, month by month, not with the standard but *with*

the original budgeted figures If the actual expenditure corresponds with these, then the standard figures will be correct without any further need for checking

Figure 83 provides a blank serviceable for this control On the left side of the blank cost figures from the various departmental standing order cost sheets are entered and a monthly and also a cumulative total taken out On the right-hand side the budgeted totals for each month (and cumulative) are entered These agree with the right-hand columns of the budget (Fig 82)

On the extreme right, two columns are provided to register discrepancies In January the budgeted total was $32, while the actual expenditure that month was $31 As this is less than budget, $1 is entered in the Cumulative Savings column In February actual expenditure per cost sheets was $37, while budget was $40 The cumulative total of actual expenditure stands at $68, while the cumulative total of budgeted expenditure stands at $72 The difference ($4) is, therefore, placed in the Savings column This figure always gives the *total discrepancy to date* If the net effect is excess over budgeted figures, the amount will appear in the Excess column, otherwise in the Savings column

Discrepancies and Their Significance—It will be seen that the control thus set up is very close As long as the discrepancies are small in amount, no notice need be taken of them But if, on the other hand, a considerable discrepancy made its appearance, it would be a case for inquiry *as to why the budget had been departed from*

The most obvious cause of discrepancy will be the putting in hand of work, as, for example, painting or kalsomining at an earlier or later date than was originally contemplated Or some considerable overhaul may have been started sooner than allowed for in the budget It will be evident that this type of discrepancy need cause no anxiety The shifting backward or forward of a budgeted item will not affect the total for the year, unless it happens so near the end of the year that a portion of the anticipated expense goes into the next year It then gives rise to a balance, which may well be carried forward to the ensuing year

Discrepancies of a small amount may also arise (1) from an alteration in the price of materials used for repairs and maintenance, such as paint, (2) from an alteration in the wage rates of workers engaged on such repairs, (3) in those cases where

Space Factor Repairs and Maintenance							____________ Dept			
Actual Expenditure Per Cost Sheets							Comparison with Budgetted Expenditures			
							Budgetted Totals		Discrepancy	
Month	Standing Order No	For	Labor	Mt'l.	Total	Comu. Monthly Total	Month	Cumu	Cumu Excess	Cumu. Saving
Jan.	S 0 502	Stairway Rep	12 00	3 00	15 00					
	503	Heat valve Rep	3 50	50	4 00					
	503	Elec. Lamp	1 00	11 00	12 00					
		Total	16 50	14 50	31 00	31 00	32 00	32 00		1 00
Feb	S 0 502	Floor Rep	19 00	2 00	21 00					
	503	Elec Lamps	1 20	14.80	16 00					
		Total	20 20	16 80	37 00	68 00	40 00	72 00		4 00

FIG 83

building repairs are carried out by outside contractors, there may be a variation in the amount of the contract price from that forecasted in the budget

The only question that arises from discrepancies of this character is in regard to their amount, or, rather, their proportion to the whole annual total of the budget As long as this proportion is small, the accumulated balance at the end of the year will not be sufficient to disqualify the standardization

Disposal of Balances —Repairs and maintenance are, as has already been pointed out, somewhat arbitrary items That is to say, they are not intimately and indissolubly connected with the work of a particular year It has been mentioned that where an important renovation or overhaul takes place, it is good practice to spread the cost over several years on the ground that near-by ensuing years are getting the benefit as well as the current year in which the work was done

Similarly, whenever a balance, either in the form of saving or excess compared with budgeted figures, remains at the year-end, no injustice is done by carrying forward this balance and including it in next year's budget, provided it does not arise from some considerable omission in the budget or some large and permanent change in prices or wages

Other Intermittent Expenditures —Belonging to this class of expenditure are all items which are seasonable in their incidence, as explained in Chap XVI Thus, the cost of current for lighting and of steam for heating fall into this category These expenditures will be budgeted and controlled by blanks similar to Figs 82, 82*a* and 83, except that there will be only one column for the cost instead of two for labor and material In all other respects there is no difference in the method of handling such seasonal classes of expenditure

Discrepancies are more likely to arise in these items Heating, for example, is very much at the mercy of the ruling temperature A below-zero spell or an unusually mild winter, in the case of heat, or a succession of dull, heavy weather, in the case of light, may make an appreciable difference between the budgeted and actual figures

As a guide to treatment of such discrepancies, we may consider what it is that we are aiming at in standardizing such charges Is it not to represent *average* conditions, taking one year with another? If it be assumed that the budgeting has been so

carefully carried out as really to represent such average conditions, then any departure from these is either a matter of unexpected profit or unexpected loss. In other words, such discrepancies may be charged off to profit and loss, provided they do not arise from errors in the budgeting or from variations in prices and wage rates of a permanent and serious character. Only scrutiny of the causes of variation each month will enable a decision to be made on this question.

Conclusion.—Handling of intermittent expenditures is carried on in three stages.

1. Items are listed and budgeted, month by month, so that a total for the year is obtained.

2. This total is prorated over working hours throughout the year so that each month gets its proper share. Every working hour bears an equal amount of the yearly total.

3. Control is effected by comparing standing order costs of the items as incurred with the original budgeted figures. Excess or saving is recorded in the form of a cumulative total or total to date, which shows the exact amount of the discrepancy that has accumulated to the end of any month.

4. Restandardization is not necessary unless the actual costs, as they come in, disclose that legitimate items have been omitted from the budgeted figures, or that serious variations in prices or wage rates have taken place. In general, accumulated total discrepancies may, at the year-end, be carried forward to the next year and next budget in the case of repairs and maintenance, without doing substantial injustice to either year.

CHAPTER XXXVII

CONTROL OF EXPENDITURES

II ANNUAL EXPENDITURES

Expenses which are annual in their nature are less subject to variation than others Thus, for example, such items as interest and depreciation, insurance and taxes are not usually liable to change of rate during the life of a budget Salaries also are generally reviewed once a year, and, if such period is made to coincide with the preparation of a budget, then no serious alteration will ensue during its life

Capital Charges —Some factors, *e g* , space factor, do not contain salary charges Their only annual expenditures are those

Annual Charges Schedule

Space Factor ______ Department

	Cap Value	I & D	Ins	Tax	Total
Building	$				
Heating Eqpt.	$				
Lighting Eqpt	$				
Total	$				3003

Assembly of Charges

	Total	Jan	Feb	Mar	Apl	May	June	July	Aug	Sept	Oct	Nov	Dec
Hrs.	2503	209	182	214	218	218	205	198	198	200	227	214	220
$	3003	251	218	256	262	262	246	237	237	240	273	256	265

Equalization of Charges on Working Hours

FIG 84

arising from capital investment Figure 84 shows a department schedule by means of which the (space factor) annual charges on capital investment in building and building equipment, and in heating and lighting equipment, are summarized and prorated over months in proportion to the standard hours in each Inspection of the blank will suffice to show its working The total ($3,003) of all the annual charges for interest and depreciation, insurance and taxes is set against the working hours (2,503) of the year, and then distributed month by month Thus January, having 209 working hours, takes $251, etc

Control —As the charges to burden account for these "fixed" charges are made from the above schedule, there is no opportunity for variation in this case, and, therefore, no necessity for control Only in the case of the change of a rate (such as an insurance or tax rate) in the middle of a financial period would alteration be required, and this would necessitate the recasting of the schedule itself

Bills for insurance and taxes will, however, not be received at the beginning of a budget period, but may come in at any time Such bills will be charged, say, to an insurance account, and the contra to the charge will be derived from the monthly charges to burden All that is necessary to watch is that the *annual* total of billed insurance is met by the *annual* total of scheduled insurance The fractional charges (month by month) will necessarily be correct if the annual totals are in agreement

Salaries —Where salaries are to be included in a factor, they may be incorporated in the annual charges schedule (Fig 84) by means of additional lines Only one total for the whole is required, which will then include (1) interest and depreciation, (2) insurance, (3) taxes, (4) salaries The total will be prorated over months in precisely the same manner as when consisting of fixed charges only

The control of salaries will be effected in the same way If the annual amount of the salaries is correctly stated on the schedule, the monthly credits to salaries account will necessarily be correct, and will completely balance the charges at the end of the year The principal precaution to be taken in regard to annual charges is to advise the accountant in charge of budgets and schedules *whenever a change takes place* in an insurance or tax rate or in a salary If this is done, no other control is needed, once it has been verified that the annual totals as set down in schedules are correct This can be done at the time of making out the schedule itself

CHAPTER XXXVIII

CONTROL OF EXPENDITURES

III HOURLY LABOR ITEMS

The control of expenditure on indirect labor under the service-factor method is very close and exact In each factor there will be certain items of hourly labor, such as cleaners in the space factor, firemen, etc, in the power factor, stores men, yardmen, crane and tractor drivers in the storage-transport factor, watchmen, messengers, etc, in the organization factor, etc It is precisely such items as these that are apt to increase without absolute legitimate need, unless careful watch is kept

No Item of General Labor—Under the older costing method a favorite classification is "general labor" into which most of the above items are thrown together and their identity lost But under the service-factor method, no such item can appear The rule is that for every item of expenditure must be asked For what specific service to production has this expenditure been incurred? Consequently, such a classification as general labor is no answer to the query, more specific information must be forthcoming If additional labor appears, it must be charged to a specific standing order number, which numbers correspond with the service-factor classification Thus, such an item must appear as additional transport service, or additional cleaning in space-factor service, and so on

The appearance of a new item, or an increase in an old item, included in any factor is a *prima facie* case for inquiry Either it is legitimate, in which case the budget is to that extent not corresponding with the true facts of production, or it is unauthorized and unnecessary, in which case it must be discontinued

Exceptional and Temporary Cases—Exceptional cases will sometimes occur If, for example, a carload of some (direct) material has been purchased, for market reasons, and circumstances require that this material shall be quickly unloaded or, perhaps, stored in a shed in a somewhat inaccessible location To this end temporary laborers are taken on and their wages, consequently, appear in the transport-factor cost sheets, as

additional to the budgeted charges What is the precise significance of this situation?

Obviously, there is an unusual condition, since, if the material had arrived in the usual small consignments and had been stored in the usual place, the budgeted service would have sufficed to deal with it The additional service, therefore represents a loss of efficiency in regard to the handling of that material It may well be that considerable savings have been effected by the purchase in bulk Well and good This additional expense is simply an offset against that saving If, regarding it as a temporary and accidental expenditure, it is allowed to go forward into service cost sheets, without modifying standard or budgeted figures, it will find its way into profit and loss and will eventually be balanced against the savings effected in cost of material as that passes into product

Substantial justice is thus done There has been a gain in the cost of material, there has been a loss in the handling of that material by unusual expenditure By leaving standards unaltered, these two effects are balanced against one another, and standard cost of service is unaffected The additional item of handling might have been charged against the material itself This would be the most accurate way but would involve a great deal of bookkeeping, while the results on profit and loss would ultimately be the same

The ultimate effect on cost of jobs must also be considered Most of the material will not be used in the current month It may, in fact, not come into use for a considerable period Obviously, therefore, the additional cost of handling has very little to do with current work By no possibility can it have anything to do with any jobs in which the material itself was *not* used It is much better not to consider it as an expenditure arising out of the regular routine of production but as a loss of efficiency below standard, and to charge it off to profit and loss By this procedure no jobs are penalized on its account Current jobs are costed at standard as usual When the new material comes into use, such jobs as employ it will benefit from the saving in price, and all other jobs will be quite unaffected

Working Rule for Handling Discrepancies —These considerations indicate what we may regard as a good working rule to apply when increased or new items of labor expenditure suddenly appear in the current accounts against a service factor Such an item may be disposed of in three ways

1 It may be chargeable against a production order If, for example, a gang was hired temporarily to assist in handling some heavy and awkward casting, which, for some reason, could not be handled by the usual tackle, and if this casting was one to be used on a production order, then such order is properly chargeable with the extra cost of handling

2 It may be chargeable against profit and loss, as in the unloading case above cited This will be the case whenever an expenditure is obviously temporary, accidental, or unusual and owes its existence to special circumstances outside regular routine and is not chargeable to a particular order

3 It may be necessary to take it into the budget If, for example, some labor item, such as a messenger, has been overlooked in making up the budget, or if, during the existence of a budget, additional messengers are engaged for *permanent* service, then new standardization is required, provided the amount of the item is so large as to influence process rates A new permanent expense is, of course, equivalent to the setting up of new conditions, and, therefore, new relations between manufacturing capacity and the cost of such capacity The existing standardization is necessarily superseded by this act

Lessened Expenditure—This is the contra of new permanent expense It is, in general, very unlikely to happen Such lessened expenditure has no relation to the cutting down of expenses in slack times It refers only to the cessation or reduction of an item of labor expenditure in a service factor when manufacturing capacity is at maximum Except in the case of reorganization (which upsets all budgets until completed), it will be rarely the case that a labor item in a service factor is either reduced or abolished

Nevertheless, such a case is possible Suppose, for example, that floor cleaning in a large department was being done by hand methods and that the use of a floor-scrubbing machine was inaugurated, leading to a reduction in the cleaning costs for that department A change of this kind would certainly modify the space factor Interest and depreciation, etc , on the machine plus the wages of the operator would probably be markedly below former cleaning costs Whether the lessened cost would be sufficient to make recasting of the space-factor budget for that department necessary will depend upon the importance of the item in relation to total cost of the factor

CHAPTER XXXIX

CONTROL OF EXPENDITURE

IV MATERIAL AND SUNDRIES IN SERVICE FACTORS

The material to be considered in this chapter is not that which enters directly into product but that usually termed "indirect" material Such material is found in most of the factors but is of minor consequence save in the case of the power factor, when it includes the important item of fuel, whether coal or oil If current is taken from public service mains, this is also considered as material for the power factor

Possible Variations in Material—The budgeted and standardized material included in each factor may not correspond with with the actual material in current accounts in two ways

1 Quantity used may have varied

2 Unit price of material may have increased, or decreased

These cases will now be considered, and their significance observed

Variation in Quantity of Material—When the manufacturing capacity of a department is normal, that is, when actual working hours correspond with standard hours, then material, as budgeted, should correspond in quantity with that actually used Minor differences may be expected, but their value should be small When discrepancy is observed (by comparison of standing order sheets with budgeted items) the *cause* must be investigated

In general, investigation will show either (1) that the budgeted amount is correct and that the discrepancy is due to waste, or (2) that the amounts actually being consumed are really necessary, and therefore, the budget is incorrect to that extent

Variation in Price of Material—This class of discrepancy is the most likely to arise In the case of fuel an advance or decrease in unit price during the life of a budget would be a serious matter and would probably lead to the necessity for new standardization Where fuel is purchased on contract, therefore, it should be arranged, where possible, for deliveries on a new

contract to coincide with the beginning of a budget and standardization period

In other matters, variations in the price of material will not, as a rule, be sufficient to affect rates, unless a period of price disturbance is assumed The amounts of material entering into factors, apart from fuel and repairs and maintenance, is small and bears but a small proportion to the total of the factor

Sundry Items in Service Factors—In this class may be included such items as stationery, blanks and books, paper telephone and telegraph charges and other office supplies and expenditures which pertain to the organization factor Supplies for the medical and other auxiliary services, if any, may also be included

The annual total of these items for a given standard manufacturing capacity should not vary seriously It is understood that all such expenses pertaining to the getting of business or sales of product are segregated and not allowed to enter production accounts

Working Rule for Variations in Material—The only working rule that can be given in the handling of variations in the quantity or price of service-factor material (including sundries) is that of observation of the monetary value of the discrepancy If it is sufficient to affect rates, then standardization should be recast Otherwise, the amount of such discrepancies may be allowed to pass to profit and loss without any serious injustice to individual costs of jobs

CHAPTER XL

CONTROL THROUGH BURDEN ACCOUNT BALANCES

Comparison of actual expenditure as charged into departmental burden accounts, month by month, with budgeted and standardized expenditure, is carried out as indicated in the foregoing chapters in four divisions

a Annual charges
b Intermittent expenditures
c Hourly labor items
d Material and sundries

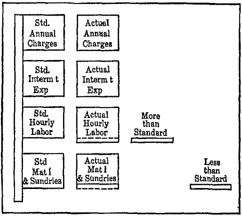


FIG 85

Standardized overhead expenditure is the cost of processes when these are working standard hours, consequently, comparisons can be made only when standard and actual hours in a given department coincide If the calendar is prepared with care, this coincidence should take place in at least nine out of twelve months, which will be sufficient to establish the correctness of standardization

Standards as Measuring Gages —In Fig 85 the relation of standard to actual expenditure on a factor in any given standard period such as a month is symbolized On the left hand a gage

with four blades is figured, and each of these, when placed against actual expenditure, measures off the correct amount Thus, annual and intermittent charges are shown as correct to standard Hourly labor, on the contrary, is higher than standard, while service material and sundries are shown as slightly below standard

The disposal of these balances depends on their significance If, on inquiry, they prove to be legitimate and permanent, this is evidence that they have been omitted when making up the budget If the amount is serious, rebudgeting is indicated If, on the contrary, they turn out to be items of an unauthorized character, or temporary and accidental in their nature, then they can be allowed to pass into profit and loss through burden account balance

Departmental Burden Accounts —While scrutiny of the charges to each service factor should be made, item by item, as outlined in the foregoing chapters, the place where actual expenditure meets standardized expenditure, whether this is done or not, is, of course, the departmental burden account

If all processes are running full time, then the credits[1] to burden account will necessarily be equal to the standard-factor charges And if standard charges correspond with actual expenditures, the credits also will be equal to actual expenditure as charged to the account through service or standing order cost sheets In this case there will be no balance left in burden account All will have been distributed through process rates to jobs

But if actual expenditure does not equal standard, there will be a balance left in burden account, which balance represents the *net* discrepancy between standard and actual expenditure The cause of this discrepancy must be traced down, as indicated in foregoing chapters

Further, if processes are not all working 100 per cent of their standard time, that is, if some of them have been idle for part of the time, then a balance in burden account will appear which will be the value of the process time wasted

Burden Account Balances Standard Working Hours —A balance in a departmental burden account, *when the department is working standard hours, i e*, neither on overtime nor short time, may, therefore, mean two different things (1) maladjustment of standard-factor expenditure to actual expenditure, (2) wasted

[1] These credits are the aggregate of all process rate charges to jobs

capacity due to idleness of processes These two varieties of balance can be distinguished and the amount due to each identified, as will now be discussed

1 *When Standard and Actual Expenditure Coincide*—Let it be supposed that a certain department is organized on the following basis, taking a particular month

214 standard working hours (March, 1929)
5 similar delivery points
Each delivery point, \$2 50 an hour
Total working hours, 1,070
Actual departmental burden, \$2,675
Standard factor charges, \$2,675

The departmental burden account, if all processes have been running 100 per cent of standard time, will show

Actual expenditure	\$2,675 00	Charged into jobs (1 070 hr @ \$2 50)	\$2,675 00

FIG 86—Normal working

There will thus be no balance in the account All of the expenditure on (overhead) services will have been distributed over jobs through process rates

1a *Same Conditions, but with Idle Time*—Now let it be supposed that delivery points have been idle 70 hr in the month The loss on these 70 idle hours will be

$$70 \times \$2\ 50 = \$175\ 00$$

Only 1,000 instead of 1,070 hr will have been chargeable to jobs Burden account will, therefore, appear as

Actual expenditure (as before)	\$2,675 00	Charged to jobs (1,000 hr)	\$2,500 00
		Wasted capacity (70 hr)	175 00
	\$2,675 00		\$2,675 00

FIG 87—Normal working with idle time

There is nothing ambiguous about this balance of \$175 It obviously represents the value of process time that has dripped into the pool of waste instead of passing into jobs

2 *When Actual Expenditure Is More than Standard*—The first case to consider is when there is no idle time Let it be

assumed that the amount by which actual exceeds standard is $50 Burden account will then appear

Actual expenditure ($50 more than standard)	$2,725 00	Charged into jobs (1 070 hr)	$2,675 00
		Balance	50 00
	$2 725 00		$2,725 00

Fig 88 —Excess expenditure

In this case the amount of the discrepancy appears as a balance, which can be checked with the comparisons made between budgeted and actual figures Its disposal depends upon its nature, as already explained

2a *Same Conditions but with Idle Time* —With an excess expenditure over standard of $50, as before, now let it be supposed that 70 hr idle time is recorded against processes Burden account will then show as follows

Actual expenditure ($50 more than standard)	$2,725 00	Charged into jobs (1 000 hr)	$2,500 00
		Wasted capacity (70 hr)	175 00
		Balance	50 00
	$2,725 00		$2,725 00

Fig 89 —Excess expenditure, with idle time

Here, after deducting the value of wasted capacity, there is again a balance of $50 left This balance as in case 2 is the excess of actual over standard expenditure

3 *Actual Expenditure Is Less than Standard* —When there is no idle time to take into account, burden account will take the following form

Actual expenditure ($50 less than standard)	$2,625 00	Charged into jobs (1 070 hr)	$2,675 00
Balance	50 00		
	$2,675 00		$2,675 00

Fig 90 —Expenditure less than standard

This balance, as it appears on the other side of the account, signifies that while standard expenditure calls for $2,675 as charged into cost, actual expenditure is short of this sum by $50

3a *Same Conditions, but with Idle Time* —If, now, under these same conditions, processes are idle to the extent of 70 hr during the month, burden account will appear as

Actual expenditure ($50 less than standard)	$2,625 00	Charged into jobs (1,000 hr)	$2,500 00
Balance	50 00	Wasted capacity (70 hr)	175 00
	$2,675 00		$2,675 00

Fig 91 —Expenditure less with idle time

The balance, $50, reappears as before, signifying that actual expenditure is $50 below standard

Burden Account Balances with Curtailed Production —We have now to observe what happens when, instead of working at standard hours, the working hours of the department have been deliberately curtailed owing to lack of work Let it be supposed that this curtailment brings working hours down to 200 hr a month, *i e*, instead of working 214 hr in the month, as arranged for in the calendar, it is found necessary to reduce working time by 21 hr , that is, 1 hr each full week day in the month (March) The new working hours will thus be 193 hr

It must also be assumed that it is found possible to produce expenditure by $195 for the month This leaves the actual expenditure at $2,495

4 *Curtailment without Idle Time* —The full working hours of processes under the curtailment will be 5 × 193 or 965 hr Assuming that there is no idle time, burden account will read as follows

Actual expenditure (Expenditure curtailed $195 below standard)	$2,495 00	Charged into jobs (965 hr)	$2,412 50
		Balance	82 50
	$2,495 00		$2,495 00

Fig 92 —Curtailed working

What does this balance represent? After charging jobs to the full number of possible working hours under the curtailment, a balance of $82 50 is left which is not part of the cost of any job This $82 50 is the cost of *irreducible and superfluous service* (*cf* Chap XIII) and is, therefore, a loss It may be said to represent the value of loss of efficiency from having to curtail production below standard working hours

4a *Curtailment with Idle Time* —With the same amount of expenditure curtailed by $195 below standard, it may now be assumed that all processes did not work full department time (965 hr), but that 65 hr of idle processes were recorded Burden account will then appear as

Actual expenditure (Expenditure curtailed $195 below standard)	$2,495 00	Charged into jobs (900 hr)	$2,250 00
		Wasted capacity (65 hr)	162 50
		Balance, as before	82 50
	$2 495 00		$2,495 00

FIG 93 —Curtailed working with idle time

Cost of irreducible and superfluous service is, as before, $82 50 in addition to loss due to wasted capacity, $162 50

Burden Account Balances with Overtime —It has already been shown (*cf* Chap XIV) that overtime may give rise either to a more efficient or a less efficient situation, according to whether the thinning out of annual charges over a longer working period is more or less than the increased service cost due to hourly service labor rates at time-and-a-half, etc In the present example we need assume only one of these cases Let it be supposed that conditions are as follows

21 hr departmental overtime in month
21 × 5 or 105 additional process hours in month
New departmental working time, 235 hr
New departmental process hours, 1,175
Additional overhead expenditure $300

The results of these new conditions will be studied, as before, with and without idle time

5 *Overtime Conditions without Idle Time* —If all machines work 100 per cent of departmental time, namely 1,175 hr , then burden account will be

Actual expenditure (Increased $300 above standard)	$2,975 00	Charged into jobs (1 175 hr)	$2,937 50
		Balance	37 50
	$2,975 00		$2,975 00

FIG 94 —Overtime working

This balance of $37 50 represents the net loss of efficiency due to overtime conditions In the given conditions it represents the excess of hourly labor items in services over reduced annual charges per hour, this excess being due to the higher rate (say, time-and-a-half) paid for service labor during overtime periods

5a *Overtime Conditions with Idle Time* —Next it will be assumed that idle process time amounting to 25 hr was recorded for the month Burden account will then be

Actual expenditure (Increased $300 above standard)	$2,975 00	Charged into jobs (1 150 hr)	$2,875 00
		Wasted capacity (25 hr)	62 50
		Balance	37 50
	$2,975 00		$2 975 00

FIG 95 —Overtime working with idle time

The balance ($37 50) reappears, after deduction for wasted capacity, and represents, as before, the loss on efficiency due to overtime conditions under the stated circumstances

Significance of Burden Account Balances —The correctness of standardization of expenditure can only be accurately determined when standard hours are being worked The conditions postulated by standardization are then present and under these conditions standard and actual expenditure will necessarily coincide, unless

a An error has been made in one or more items

b Illegitimate expenditure is being charged to overhead

c Temporary and accidental items of small amount have been incurred

1 *Under Standard and Working Hours* —When budgets and actual expenditure are compared, factor by factor and item by item, the location of any departure from standard is readily detected From what has been said in this chapter, it will be evident that the *net* totals of all such aberrations from standard will be found in burden account as shown by Figs 88 and 89, wherein the balance ($50) is the net effect of all such discrepancies Also in Figs 90 and 91 where the $50 balance is on the other side of the account

The amount of this balance in burden account *will usually be the controlling feature in determining whether new standardization is necessary* If such a balance is due to errors in budgeting,

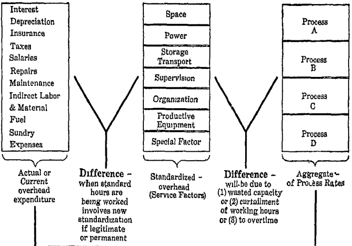
and is important in amount, new budgeting and standardization for the department is indicated But if the balance is due to extravagance and illegitimate expenditure on some service item, it should be charged off to profit and loss This will also be the destination of a balance due to some temporary expenditure, not of a routine nature, as explained in a former chapter It need hardly be said that conditions like those assumed in Figs 90 and 91 are rare Discrepancies will usually be in the shape of excess actual expenditure

2 *Curtailment Conditions*—Comparison of budgets with itemized actual expenditure is not as revealing in the case of curtailment conditions as under standard hour working, except to the extent that no items should show increase, and certain of them should show some decrease Actual expenditure should be less than standard under curtailment, but how much less cannot be defined and is a matter of experience in the particular plant

Under curtailment, the balances in burden account, after any loss due to wasted capacity has been deducted, (*cf* Figs 92 and 93) must be assumed to represent irreducible and superfluous service If no budgeted item has been increased, this will be true But only a careful scrutiny of factor items with budget will ensure that it is true In other words, burden account balances *alone* should not be relied upon They represent the net result, but some item may have been above normal all the same

3 *Overtime Conditions*—The same remarks apply to burden balances under overtime conditions On comparison with budget, some items will have increased, but to what degree they should have increased is a matter for judgment based on experience No item should show decrease Though the effect of overtime is to thin out annual charges over working hours, the total charged into burden is the same as under standard hours The charge itself is not decreased

The balance in burden account, after deducting wasted capacity, will represent the net loss of efficiency due to overtime conditions As explained, this may, under certain circumstances and in certain industries, be a gain instead of a loss, but more usually the effect of heavy increases in hourly labor rates for service work will overcome the thinning out of annual charges The balances show the net result of the increased expenditure due to working overtime



Dr	DEPARTMENTAL BURDEN ACCOUNT	Cr

I. PRODUCTION UNDER STANDARD WORKING HOURS

1 With **actual expenditure normal with standard** and **pro duction 100 / *of standard manufacturing capacity*** *there will be* no balance. All overhead expenditure will have been distributed over jobs See Fig 86

1a. With **normal actual** expenditure and **production at less than maximum capacity** a balance will appear which will be the *cost of wasted manufacturing capacity* See Fig 87

2 When actual expenditure is **higher** than standard and ***production is 100 % of maximum*** capacity a balance will appear which represents the **net value** of the excess expenditure See Fig 88

2a When **actual** expenditure is higher than standard and production **is at less than maximum** capacity the balance may be divided into two parts, one representing cost of wasted manufacturing capacity and the other the net value of excess expenditure, See Fig 89

3 When **actual** expenditure is **less** than standard **and production is at 100 % *of maximum capacity*** the balance will represent the net excess of standardized expense over actual See Fig 90

3a. When actual expenditure is **less** than standard and production **is at less than maximum capacity** the balance is divisible into two portions one representing cost of wasted capacity and the other the excess of standard over actual expenditure See **Fig 91**
Both the conditions 3 and 3a would be unusual unless due to error in standardization.

II PRODUCTION DELIBERATELY CURTAILED (SHORT TIME)

4 With curtailed production and when **production is 100% of the maximum (reduced) working hours**, the balance will represent loss of efficiency due to irreducible but superfluous service (Cf Chapter) XIII Fig 92 shows this condition

4a With curtailed production and **actual process hours less than the new maximum** the balance can be divided into two parts one showing the cost of wasted capacity and the other the loss due to curtailment conditions See Fig 93

III. PRODUCTION UNDER UNEXPECTED OVERTIME

5 If overtime is worked not included in calender, **and production is 100 / of the new maximum** working hours then the balance will represent loss of efficiency due to overtime conditions Under certain circumstances (Cf Chapter) XIV it may be a gain in efficiency See Fig 94

5a. If overtime is worked **as above** but production is **less than 100 % of new maximum** working hours then the balance can be divided into two parts one representing the cost of wasted capacity and the other the loss of efficiency due to overtime conditions, See Fig 95

FIG 96

Diagram of Burden Account Control—Figure 96, a diagram, shows the control effected by observation of balances in burden account, and also exhibits the relation of standard factors to process rates, on the one hand, and to actual expenditure on the other. Reference is made to the different conditions of working enumerated in this chapter. The items 1, 1*a*, etc., correspond to similarly numbered paragraphs in the preceding pages.

Note as to Process Rates—Throughout this chapter a single-type department with five delivery points all having the same process rate has been assumed. This has been done for easy following of the calculations. The same results would, of course, follow if a plural-type department with several processes having different rates had been assumed, but, in this case, the multiplication of wasted hours by a single rate would not have been possible, so that more elaborate details would have been necessary. Either type of department might have been selected without altering the argument or the deductions.

CHAPTER XLI

WASTED CAPACITY RATIO SUPPLEMENTARY RATE

While the cost of processing a particular job and the amount of wasted capacity that may be going on at the same time in the department have nothing to do with each other, it is possible to establish an arbitrary or mathematical relation between the utilized *capacity* and the wasted *capacity* in any given period This ratio, once established, may then be extended, if desired, to individual jobs

Thus, if in a certain department (*cf* Fig 87), the utilized capacity in the month, *i e*, process cost charged into jobs, amounts to \$2,500 and if, during the same month, capacity has been wasted to the amount of \$175, then, $\frac{\$175 \times 100}{\$2{,}500} = 7$ per cent Wasted capacity as a whole is 7 per cent of utilized capacity

If a particular job has cost \$140 for processing, we may, if desired, state the cost of the job in this form

Direct labor	\$ 60 00
Process cost	140 00
Ratio of waste (7 per cent)	9 80
Inclusive "cost" of job	\$209 80

The Supplementary Rate —This method of disposing of the cost of wasted capacity was, in fact, recommended by the author in "Proper Distribution of the Expense Burden" and in "Production Factors" when the present method of costing was first published Some explanation of this may be of interest At the time in question, nearly twenty years ago, the idea of separating wasted capacity (idle time) from true cost of jobs was entirely new and unfamiliar No other method than that of percentages, and, to a small degree, hourly burdens, was in use, and, in introducing the new views on overhead, it was desirable not to depart too far from established usage, which, of course, called for the prorating of *all* current expenditure over current jobs By the device of the waste ratio, or as it was termed the "supplementary

rate," this complete prorating was still possible, although the author was careful to point out that it was not essential, and that the waste ratio was not and could not be part of true cost

As it turned out, no element of the new method was more severely criticized than the "supplementary rate" It was (somewhat to the author's surprise) generally recognized that it was no part of true cost and that, therefore, wasted capacity should be charged off to profit and loss Today, this idea is so generally accepted that there is perhaps no danger in the contrary course But at the time of the original publication of the method, this was by no means the case, and the dangers were perhaps too much emphasized by the writer

Utility of the Supplementary Rate —The danger in question lies in the possibility of wasted capacity being covered up and not brought to the notice of executives If every cost of an order carries, *as a separate item*, the ratio of waste current at the time of its manufacture, it is impossible not to observe its existence If charged off to profit and loss each month automatically, it would be more likely not to attract attention Under modern methods of record, however, this danger may be considered as not very serious

Apart from the question of hidden waste, there are certain conditions under which the supplementary rate is still useful Its use in seasonal operations was described in Chap XV It may also be of service in other cases, which may be glanced at briefly

Under certain conditions prices may be based on other considerations than strict cost of processing In the armor-plate industry, for example, idleness of the whole plant is a not infrequent occurrence, but the cost of this has to be recovered in whatever contracts are entered into Similarly, a repair department may be maintained at some strategic point, by a large corporation, to hold business The cost of repairs is not wholly based on process cost, but something may be chargeable for upkeep of the shop when not fully employed A third instance is that of a government dockyard maintained in some out of the way place for service reasons Idleness of the equipment and organization may be considerable and is due to what may be called "military preparedness" The cost of work actually done is perhaps small compared to the cost of wasted capacity which is unavoidable In this case, also, it would seem to be

good policy to frame costs so that the waste ratio was placed alongside true cost as a memorandum of conditions

In fact, as long as it is thoroughly understood that a supplementary rate is merely a ratio of utilized to wasted capacity, there can be no objection to stating costs in the form given on the first page of this chapter, *if greater grasp of the situation is thereby secured* In ordinary circumstances, however, it is not necessary

PART V

COSTS, SALES AND PROFITS

CHAPTER XLII

THE INTERPRETATION OF COSTS

The treatment of overhead on the service-factor and process-rate method, that is, standardized overhead, has now been outlined in full On the one hand we have a definite annual manufacturing capacity for the whole plant, and on the other the annual legitimate expenditure on overhead which is the cost of this capacity The plant capacity is, however, subdivided for practical purposes into departmental capacity, which may, if necessary, be further subdivided into individual process capacity in those cases where (plural-type departments) processes requiring different rates are found in the same department Similarly, the legitimate annual expenditure on overhead for the whole plant is subdivided into departmental overhead expenditure, and this, in turn, is resolved into an annual overhead charge, *for the given capacity* of individual processes In other words, manufacturing capacity is first standardized and then the correct cost of this capacity is also standardized

If any part of the capacity so provided and maintained is not utilized on product, but drips into the pool of waste, the cost of this wasted capacity is ascertained separately, leaving true process cost unaffected

Reviewing the Financial Period —At the end of a financial period, which may be 1 or 3, 6 or 12 months as desired, the following results will be observable

1 There will have been a certain output of product at standard process cost plus direct-labor cost, if any

2. A certain amount of manufacturing capacity will have been unutilized, by reason of the idleness of process, for various reasons The ratio of this to utilized capacity can be expressed, if desired, by a waste ratio or supplementary rate

3 There may be a small amount of overhead expenditure which is in excess of (rarely below) standard and is neither included in costs or in wasted capacity

4 A credit balance of interest will have been built up, representing the interest charged into costs on capital investment and (if desired) on the average value of direct material held in storage

5 A credit balance of depreciation will have been built up, representing the wear and tear of property which has been charged into cost

Interpretation of These Results —Figure 97 presents these results in diagrammatic form In this figure *a* represents cost of direct material on the jobs worked on during the period This is included for the sake of completeness but does not affect

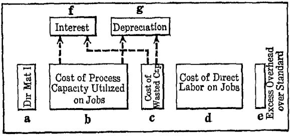


FIG 97

the overhead problem at all Next, *b* and *c* represent the total cost of manufacturing capacity for the period In particular, *b* represents that portion which was utilized in processing jobs and *c* that portion which dripped into the pool of waste Direct labor is represented by *d* to make the story complete but does not enter into the overhead problem Finally, *e* represents any small excess of actual over budgeted expenditure that may have been observed and is either of a temporary and accidental character, as explained in former chapters, or is so small in amount as not to affect process rates, or is a loss incurred through lessened efficiency during overtime or short-time condition [1]

These values *a* to *e* represent the outgoings during the period To set against these for profit and loss purposes we have (1)

[1] This item might, on occasion, be a credit, when overtime sets up a condition of increased efficiency, as explained in former chapters The case, however, is rare

a certain quantity of product, (2) a credit for interest which has been charged into cost of capacity, represented in the figure by f, (3) a credit for depreciation, g in the figure, which is the amount of wear and tear on capital values that has been charged to manufacturing capacity in the period

1 *Gross Profit on Sales at Standard Cost*—In order to ascertain the financial results of the period, cost of product at standard

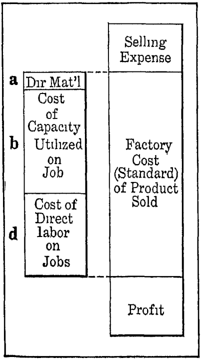


FIG 98

cost must be set against revenue from sales of this product, selling expense being first deducted Figure 98 shows this arrangement The right-hand column represents the total sales revenue Selling expense being marked off at the top, cost of product is applied and measured off The remaining space represents gross profit made on the sale of the product in the period

2 *Net Results of the Period*—Finally, Fig 99 shows disposal of this profit, and of the interest and depreciation funds f and g,

above mentioned Gross profit and this interest are added together, forming one side of the account, while, out of this aggregated profit, certain items must be paid for, leaving net or distributable profit

First, we have to deal with waste This item is made up of wasted process capacity c and excess overhead e Then any legal expenses, charities or other expenditures which are neither manufacturing or selling expenses are marked off Part of the remaining profit may be reserved for purposes that we need not discuss, leaving the lowest rectangle representing distributable profit The depreciation fund g does not enter into the account, as it is not a new value but merely a transfer of a part of capital value from one account to another It represents capital value that has vanished or, rather, been used up in providing manufacturing capacity, but which value has been put into cost of such capacity and is therefore, *already reserved from profits* If this had not been done, the amount would have swollen profits to that extent and another rectangle would have appeared on the right-hand side of Fig 99 representing "depreciation reserve"

Why Interest Is Included in Cost of Capacity —While depreciation has now practically won its place as an element of production

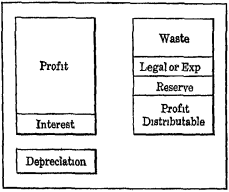


FIG 99

cost, and the old practice of setting an arbitrary sum aside out of profits (equivalent to an additional rectangle in Fig 99, as above described), which sum varied according to the state of mind of the board of directors at the time, is now largely discredited But as to the importance (and indeed necessity under modern conditions) of also including interest in the same way,

agreement is by no means uniform or universal Many accountants continue to insist on considering interest as an item which should be omitted so as to swell gross profits, on the ground that interest is not payable until it has been earned This matter is important enough to be discussed in some detail

Let it be supposed that a certain machine is in use of which the capital value is $1,000 and the depreciation rate 8 per cent Annual charges will be

$1,000		$1,000	
Interest 6 per cent	$ 60	Interest	
Depreciation 8 per cent	$ 80	Depreciation 8 per cent	$80
Including interest	$140	Excluding interest	$80

Neglecting other items, we may say that the cost of process capacity per year is $140 if we include and $80 if we exclude interest

Now let it be assumed that it is proposed to replace this machine by another costing $2,000, with a depreciation rate of only 4 per cent In other words, it is a more solid, heavier and, perhaps, a more slowly moving machine, though with some advantages such as more perfect work, which indicate its adoption The corresponding charges for the new machine will be

$2,000		$2,000	
Interest 6 per cent	$120	Interest	
Depreciation 4 per cent	80	Depreciation 4 per cent	$80
Including interest	$200	Excluding interest	$80

If we compare the two rates in which no interest is charged, we find that each machine has the same rate, namely, $80 a year, notwithstanding that one has cost twice as much as the other Can this be considered as a true representation of facts—of *all* the facts? Whether we recognize the fact or not, we have locked up $1,000 additional in the new machine, and this $1,000 would have earned us $60 if it had been put out at interest instead of being so locked up

It is evident that the new machine must earn $60 a year more than the old one, if it is to break even Moreover, it is plain that if this kind of substitution were extensive, we should presently have an enormously increased capital locked up in equipment, but would be *charging no more into costs than before* [1]

[1] Except for depreciation, which only *replaces* capital but does not provide interest on it or assist in the earning of a dividend

At the present time, when the tendency is to replace labor by mechanism, these considerations appear somewhat important

On the other hand, when we compare the rates in which interest has been *included*, we get a result which has some significance The old machine rate was \$140 per year, while the new is \$200 This result is, obviously, a nearer approximation to the facts of the case

Interest is, in fact, the only measure of the relative use of capital by processes that we can apply It is directly proportional to such relative use, consequently, a process involving costly equipment should be made to bear the extra cost of capital charges as compared with a similar process using cheaper equipment In general, unless the sale price of a product is sufficient to cover the cost of including interest on the capital used in maintaining manufacturing capacity (except in times of extraordinary depression), the product is unprofitable

Effect of Mechanization of an Industry —The effect of replacing skilled labor and hand labor generally by equipment, or, in other words, the *mechanization* of an industry, is worth considering in some detail In Figs 100 and 101 we have data on two factories, one of which is old style and the other we may assume to be entering the business with complete modern equipment and methods To study the effect of mechanization, all quantities not concerned will be held constant, thus

a The same output is assumed for both plants

b \$12,000 working capital beyond that locked up in equipment is assumed for both plants

c Depreciation at 6 per cent on equipment in both plants

d Interest, where charged, at 6 per cent in both plants

e It is assumed that, in this industry, selling price is usually determined by adding 20 per cent to factory cost

f Selling expense is reckoned as 5 per cent on sales price in both cases

The *differences* between the two plants are

g The first plant has \$12,000 locked up in equipment (buildings, productive and service machinery, etc)

h The second plant has a capital investment in equipment *more than four times larger*, namely, \$50,000

i The first plant spends \$4,500 on direct labor and \$4,780 for service cost, but interest and depreciation on the equipment is *not included* in this service cost, and is shown separately

3 The second plant, by reason of its mechanization, has reduced direct labor to $2,000 and its service cost (also *excluding* interest and depreciation) to $2,000

1 *Costs and Profits in the First Plant*.—Figure 100 shows the course of operations in the first plant Total cost of direct labor, service (factors), depreciation, and interest amounts to $10,720, 20 per cent on this cost gives $12,864 as the selling price After deducting 5 per cent selling expense and factory cost, we have left $1,501, to which is added the $720 already set aside as

Case 1 Plant depending on skilled labor and elementary machinery

Capital employed $24,000 { $12,000 in equipment; $12,000 other }

Dividend of 6% on capital employed will take $1,440

Output for Year

Item	Factory cost	20% on cost	Selling price	Selling exp 5%	Profit
Direct labor	$ 4 500				
Service cost[1]	4,780				
Depcn 6%	720				
Total	$10,000	$2,000	$12,000	$600	$1,400
Int on eqpt 6%	720				
Total	$10,720	$2,144	$12,864	$643	{ $1,501 720

First profit will not pay 6% Second profit will pay 9¼%

[1] Service cost not inclusive of depreciation or of interest

FIG 100.—Plant depending mainly on skill

interest charged into cost Total earnings $2,221 This provides 9 25 per cent dividend on the capital $24,000

If, however, interest had *not* been included in cost, the factory cost would have been $10,000, which, with 20 per cent on and 5 per cent on sale price, as before, would result in a profit of only $1,400, which would not quite pay 6 per cent on the capital investment The sale price would, however, be slightly lower (100 93 5) This result merely implies that the normal 20 per cent added to factory cost to get sale price is insufficient, in this case, if interest is not included It would require a rate of about 21 5 per cent to give sufficient profit to pay 6 per cent dividend

In other words, this business is in no very strong position, if 20 per cent on a factory cost which does not include interest is the usual practice in the trade Actually, its sale price must realize at least $12,144 if it is to pay 6 per cent dividend

2 *Costs and Profits in the Second Plant*—It may be assumed, in the case of the second plant, that its product is in active competition with that of the first but is not an identical product It may be considered as a substitute that depends upon undercutting in price, so that a pound of the new must be sold a little

Case 2 By investment four times greater in equipment, direct labor is reduced to 45% and overhead (excluding depreciation and interest) to 42% All other items remain as before

Capital employed $62,000 $\begin{cases} \$50{,}000 \text{ in equipment} \\ \$12{,}000 \text{ other} \end{cases}$

Dividend of 6% on capital employed will take $3,720

Item	Factory cost	20% on cost	Selling price	Selling exp 5%	Profit
Direct labor	$ 2,000				
Service cost*	2,000				
Depc'n 6%	3 000				
Total	$ 7,000	$1,400	$ 8,400	$420	$980
Int on eqpt 6%	3,000				
Total	$10,000	$2,000	$12,000	$600	$\begin{cases} \$1\ 400 \\ 3{,}000 \end{cases}$

First profit will pay only about 1½% dividend

Second profit will pay 7% dividend and is based on a sale price which competes with the lower (inadequate) price in Fig 100

FIG 101—Plant completely mechanized

under the price of the old to gain the market The output in pounds of the two factories is considered to be the same

The course of operations yields the following Yearly cost, *including* interest, amounts to $10,000, 20 per cent on this gives a selling price of $12,000 Deducting factory cost and 5 per cent selling expense, we have left $1,400, which, added to $3,000, earned by processes and charged into cost on account of capital investment, gives $4,400 in all This will pay 7 per cent on the total new capital of $62,000 on a sale price lower than must be obtained by the first plant if it is to pay 6 per cent dividend

But if we had not included interest in cost, the result would have been as in the line above A sale price of $8,400 would have resulted, and a profit of $980, or only about 1 5 per cent on the capital

The point to observe is this If the first factory had applied its normal 20 per cent on factory cost *without* interest, its operations would still have yielded $1,400 which would have provided about 5 8 per cent dividend on the capital But if the second factory had done the same thing, it would have realized only $980 profit, which is not more than 1 5 per cent on its (increased) capital This means that the 20 per cent is *wholly insufficient to provide an adequate margin in the case of the highly mechanized factory* What would be a fair approximation in the old-style business is hopelessly wrong in the mechanized business As a matter of fact, to get the satisfactory selling price of $12,000, no less than *seventy-one-and-a-half per cent* would be the proper figure to use instead of 20 per cent

But when factory cost *includes* a charge for the use of capital, then the normal 20 per cent gives satisfactory results again

Inference from the Two Cases—These figures are, of course, arbitrary, and other figures would produce different results Nevertheless, they do exhibit conditions which are not uncommon today Where capital investment replaces direct labor and considerable service cost, *the most serious misapprehensions as to the necessary margin of profit are likely to arise* The two plants above discussed afford an example of such a situation It is true that other figures might minimize the inference, but still other figures drawn from actual instances might provide even more striking confirmation of this inference

In Fig 102 the way in which annual cost of output in the two plants is made up is shown diagrammatically The left-hand column represents the first plant and the right-hand the new plant In both cases interest is included Total cost in each case is not very different, but the composition of the cost is utterly different Moreover, in the one case only $720 has been charged into cost for the use of the elementary equipment in use, while in the new plant $3,000 has been so charged

If from both columns the lowest sections, representing capital charges, are removed, then the new cost appears enormously smaller than the old *But is it really so?* It is the present writer's contention that a charge into cost for the use of capital

locked up in equipment is as legitimate and as necessary as a charge for the use of direct labor Under modern conditions it is, indeed, a payment *for the skill formerly paid for as labor* in another form Skill has been transferred to the machine but only at a great capital outlay The annual cost of this outlay,

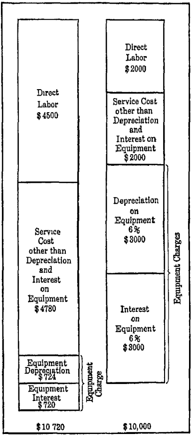


FIG 102

that is, interest on its amount, is as natural a part of true cost as were the wages which formerly represented that same skill

Divergent Views —The objection to the inclusion of interest on equipment in costs comes usually from accountants whose comprehension of overhead and its real place in relation to cost is limited to the old vague mathematical relationships—ratios

and hourly burdens Seeing overhead as a mass of figures having no ascertainable relation to the only things that they were able to determine with precision, namely, direct labor and direct material (or what used to be called "flat cost" or "prime cost"), it is not surprising that the utility of including an additional item in the jumbled mass was not very apparent It was, in fact, almost entirely useless under the older methods of costing But when interest is allowed to act as the natural measure of the *use* of capital in production, the matter takes on another aspect While service factors and process rates *can* be set up without including capital charges, to do so would be to falsify them under normal conditions, and, therefore, render them much less reliable as measures of the *relative* as well as the absolute cost of processing than is otherwise the case

CHAPTER XLIII

THE FIXING OF PRICES ESTIMATING

The question of pricing and making estimates for bids is so large a subject that it can be treated only cursorily here Four aspects alone will be considered (1) the fixing of selling price in a new business, (2) the making of a price on a new article, (3) sales through a selling corporation, (4) estimates based on detail costs already on record, which are subject to modification under current conditions

Pricing in General—Some of the difficulties attending the setting of prices were discussed in the previous chapter Nor are these the only difficulties, for the fixing of a price is a slippery business, as many executives know to their own cost In the discussion that follows it will be assumed that service factors and process rates as described in the previous chapters are in use It will also be assumed (*a*) that a single product is in question, (*b*) that the plant has been erected and organized for a certain known capacity, (*c*) that the selling arrangements usual in the industry for this quantity of product have been worked out and their annual cost estimated

We begin, therefore, with three known elements (1) quantity of output, (2) cost of output (3) cost of selling this output The problem is to settle an adequate selling price

1 *Erroneous Method of Estimating Margins*—The inexperienced executive is apt to make a typical error at this stage With, for example, a factory cost of $10,000 and an estimated selling expense of $500 (5 per cent), he will proceed to figure that if he adds another 35 per cent to factory cost, he will have a 40 per cent margin on his output to cover selling expense, contingencies and profit But if this calculation is put to the proof, it will be found to work out very differently, thus

Factory cost	$10,000
40 per cent 'on"	4,000
Selling price	$14,000

NOTE—Factory cost is process cost and direct labor and direct material

At the end of the financial period, the matter will stand in the following condition

Selling revenue		$14,000
Factory cost	$10,000	
Selling expense	500	
Margin	3,500	
	$14,000	$14,000

NOTE —In this example interest charged into cost is ignored It may be assumed as not so charged

But this margin is not 35 per cent of the selling revenue, it is only 25 per cent If the *amount* concerned, namely $4,000, has been kept in mind, then the error in percentage may not

Percentage "on"	Ratio of addition to new total (sale price)	Percentage of profit on sale price
10	10 110	9 10
20	20 120	16 66
30	30 130	23 07
40	40 140	28 57
50	50 150	33 33
60	60 160	37 50
70	70 170	41 17
80	80 180	44 44
90	90 190	47 36
100	100 200	50 00

Example 70% on $750 = $525 Sale price is $1,275 The amount added, *viz*, $525, is 41% of this sale price, not 70%

FIG 103 —Relation of amounts " on" to new total (sale price)

lead to any trouble But if, as is almost certain to be the case, having fixed 35 per cent as the percentage involved in the transaction, the executive applies this percentage mentally to his selling revenue, he will be expecting 35 per cent as his margin on each order or sale, whereas he will get only 25 per cent

Though few executives with trading experience would fall into this trap, beginners in manufacturing (particularly technical men without commercial experience) are apt to do so Moreover, in reference books this method of ascertaining profit is sometimes given without a word of warning Thus, for example, in a slide-rule manual the caption *To find the selling price of goods to*

yield a given percentage of profit turns out to be, when applied to an example, precisely similar to the method above described The "given percentage of profit" as found by the formula is one which is applicable to the factory cost and not to the selling price

No simple formula will yield a given percentage of profit on a selling price made by putting a percentage on a factory cost This, perhaps, is the reason why handbooks and manuals give the above method, the compilers probably not being aware themselves of the practical consequences To exhibit the relations between percentage "on" and the resulting percentages on sale price, the table in Fig 103 is presented

Factory cost (inc $3,000 interest)		$100,000
Selling expense, calculated at		6,500
Allowance for wasted capacity, etc		2,000
Legal and similar expenses		500
Reserves for contingencies		3,000
		$112,000
Required margin for profit	$13,000	
Less interest in cost	3,000	10,000
Inclusive selling price of output		$122,000

Fig 104

2 *Correct Method of Fixing a Price*—In setting out to fix a price for factory output, several things must be kept in view A sale price is made up of several factors, chief of which are

Factory cost of goods (standard cost)
Selling expenses
Cost of wasted manufacturing capacity
Cost of selling inefficiency [1]
Legal and similar expenses
Reserves for various purposes
Margin of clear profit available for dividend

As a credit to these items, the amount charged into cost for interest on capital investment will come into account An example on these lines will now be worked out, the figures being arbitrary and serving merely to show the principle involved

To begin with (Fig 104) we have two known quantities—factory cost $100,000 (which we will assume to include $3000 interest charged into cost) and selling expense, which has been calculated at $6,500 The following additional estimates are

[1] Only when selling expense is standardized

then made wasted capacity and other inefficiencies as described in previous chapters $2,000, legal and other expenses not allocable either to selling or production, $500, reserves for contingencies, $3000. The total of all these items will be $112,000.

Next we have to decide what amount of clear divisible profit is necessary to pay the desired dividend (whatever that may be) on capital. Suppose that $13,000 is this sum. But of this $13,000 we have already a credit for $3,000 from interest charges into cost. The net amount to be added to the $112,000 already assessed will therefore be $10,000. Aggregating these items, a total sale price for the output results, namely $122,000.

Two useful percentages may be derived from the above. Selling expense is 5.33 per cent of selling price. Profit is 10.66 per cent of selling price. If the actual results of the first financial period confirm these figures, these percentages form a useful datum for future use.

Further, we may *now* say that selling price is 22 per cent on factory cost, but this remains true only while the components calculated above are unaltered. If, now, the factory output contains several lines, then the selling price of any one of them can be approximated by adding 22 per cent to the standard factory cost. These are the only safe conditions in which an on percentage can be used, namely, to price an individual unit when it is *known* that the percentage applies correctly to the output as a whole.

Pricing a New Article.—Under normal working conditions and assuming that the new article does not demand selling effort on a different scale or in different forms from that in general use at the time, the on percentage as described in the last paragraph may be used to ascertain the selling price. If, for example, the standard factory cost of a batch of the new line is $1,000, then its selling price will be $1,220.

If, however, new kinds or amounts of selling effort (such as advertising special to the new product) are involved, then the price will be $1,220 plus the cost of the *extra* selling effort, which, of course, is chargeable only to this product and must not affect the sale price of other products.

Sales through a Selling Corporation.—When the entire output of a factory is taken by a separate corporation, the question arises. At what price should the output be billed from the factory to the selling concern? Remembering that, on the one hand

factory price at standard does not include the cost of wasted capacity and other inefficiencies, and, on the other, that the factory accounts include interest provided for in respect to use made of capital investment, it is evident that either of two courses may be followed

1 Product may be billed at standard cost, and the credit for interest on capital reserved by the factory and set against wasted capacity In this case the sales corporation has to consider only one element in its accounts, namely, *standard* factory cost of product The factory, on the other hand, will set up a profit and loss account of its own, and this will show a profit or a loss according as the cost of wasted capacity, etc , is more or less than the interest fund Factory and sales corporation are each absolutely on its own merits with this plan

2 The slack may be taken up by the sales corporation Product will be billed at standard cost Wasted capacity will also be separately billed A credit will be billed for the interest charged into cost These three items will meet in profit and loss account, just as though factory and sales were all one business

It is obvious that this latter arrangement might be varied by considering factory cost as made up of

Cost at standard	$100,000
Wasted capacity, etc	2,000
	$102,000
Deduct interest	3,000
Net factory cost	$ 99,000

This factory cost would, however, be a varying quantity for the same volume of output It would, in fact, be much like the result obtained from a percentage or hourly burden method The final result would be the same as though goods were billed at standard and other items taken into the profit and loss account of the sales corporation, as in 2

Solution of the Dilemma —We are faced with a dilemma in this instance, and this is set up by our action in separating the natural sequence of events

Manufacture—Sales—Profits

into two groups, into neither of which will profit absolutely fit Profit is the result, in ordinary businesses, of a chain of events, any of which may originate influences to affect such profit That is

to say, waste and inefficiency in the factory, as well as waste and inefficiency in selling, will affect profits By putting manufacturing and selling into two compartments we set up a dilemma, because manufacturing waste (and also the interest fund originated by charging interest into cost) is left out of the scheme

If factory cost of product were always 100 per cent of standard cost, no such difficulty would arise If wasted capacity were even a standard and invariable quantity in itself, adjustment would be easy But it is not It is always a more or less variable amount, and it *has to be paid for by someone*

It must, of course, be paid for through a profit and loss account If there is only one such account—that of the selling corporation—then all items must meet there, which is practically throwing everything into one business again But if the factory has a profit and loss account of its own, then the two divisions—*Manufacture—Sales*—are wholly separated and events will be recorded, thus

Manufacture—Profits
Sales —Profits

The efficiency of each division then rests on its own shoulders This is the arrangement, 1, described above If desired, a small profit may be added to factory cost before billing to the sales corporation, so that the balance in profit and loss will always be on one side

The Making of Estimates for Bids *Normal Times* —Estimating is an altogether different operation from that of pricing In pricing we must begin always with a standard factory cost already determined In estimating, it is this factory cost which is the subject of investigation When it is determined, the article can then be priced on the method discussed elsewhere in this chapter

The only case we can take up here is that of a call for an estimate on a product that has already been through the factory and of which cost records exist It is assumed, however, that the cost figures in these records are no longer correct, owing either (1) to changes in prices and wages since the last time of production, or (2) because current conditions demand that the estimate should be cut to the bone, or (3), alternatively, based on a long spell of overtime which the acceptance of the bid would entail

1 *Variations in Prices and Wages* —Recalculation of costs will be considered in three divisions

a Where process rates have been altered
b Where direct-wage rates have been altered
c Where prices of direct material have varied

It is, of course, assumed that the cost sheets provide a record of the process *time* on all details of the work With this time as a basis and a list of current process rates we proceed to check all process rates on the old sheets and if one has varied, that item is recalculated at the new rate A list of direct-wage rates pertaining to each process is also provided and any variation from former rates of pay will imply a recalculation of the item With regard to direct material, the records will show the prices current at the former date of production, and these will be checked with current prices for the same material and the estimate revised accordingly

Date ______April__			1929_	Part H J K		
Process No	Time	Pro Rate	Process Cost	Wage Rate	Direct Labor Cost	Total
46	1 hr	4 75	4 75	35	*0 35	5 10
47	2 hr	3 50	*7 00	45	0 90	7 90
48	1½ hr	2 40	3 60	60	*0 90	4 50

FIG 105

2 *Indirect Labor and Material Do Not Require Revision* —No attention need be paid to changes in the wage rates of indirect labor or in the price of indirect material Any variations in these items which may have taken place since the date of previous production are *taken care of by the current process rates* The work of preparing a revised estimate of a job is thus greatly simplified and also rendered very much more exact than under older methods of handling overhead

3 *Routine of Estimating* —Figure 105 represents the record of cost of a part HJK made in April The cost of processes 46, 47 and 48 is recorded as shown To make an up-to-date revision of this cost, the current list of process rates and their corresponding direct-wage rates (Fig 106) are taken and compared with the rates on the cost record, a mark being placed against those which have varied An estimate blank (Fig 107) is then filled out

Unaltered items are merely copied from the cost record, but where changes in rates have taken place the *new rate*, whether process or wage, is inserted in the estimate and a new cost for that item calculated. The heavy black figures show items which have been treated in this way.

Effective *September* 1929		
Process	Pro Rate	Wage Rate
46	4 75	40 ¢
47	3 60	45 ¢
48	2 40	65 ¢
49		

FIG 106

The resulting estimate is one which should be turned into actual cost very exactly when the job comes to be put in hand. Revision of material need not be considered in detail here. The bill of material will simply have its prices revised in accordance with current prices, and fresh calculations made of any items that have changed in price. Only *direct* material, namely, that

Estimate *Oct 5* 1929				Part H J K		
Process No	Time	Pro Rate	Process Cost	Wage Rate	Direct Labor Cost	Total
46	1	4 75	4 75	**40**	**0 40**	**5 15**
47	2	**3 60**	**7 20**	45	0 90	**8 10**
48	1½	2 40	3 60	**65**	**0 97**	**4 57**

FIG 107

forming part of the salable product, need be considered. All indirect (service) material is taken care of by the current process rates.

Estimates under Hard-times Conditions.—The foregoing method of preparing an estimate based on previous performance is that which is followed when it is desired to obtain a factory cost suitable for ordinary conditions of trade. It may happen,

however, that, when business is in a condition of extreme depression, it becomes necessary to prepare an estimate *cut to the bone*. In other words only absolute out-of-pocket expenditure can be permitted to enter the estimated cost of production.

This unfortunate condition can be taken care of without much difficulty by the service-factor and process-rate method. When a period of depression sets in, service-factor schedules are gone over and all items struck out which do not represent out-of-pocket expenditure. New process rates are then calculated, and these can be listed and used precisely as those in Fig. 106 for the preparation of a rock-bottom estimate.

It will be obvious that any desired *degree* of reduction can be attained in this way. The first stage would be to omit interest, a second stage to omit both interest and depreciation. All indirect labor that could possibly be spared would also be omitted, even though, at the moment, this reduction had not taken place. In fact, the rates might be reduced so as to include only wages and materials actually necessary to maintain the reduced degree of capacity. By means of an electric calculating machine revised factors and rates can be very quickly calculated, as the striking out of items and reduction of amounts is the chief task. The skeleton form of the factor schedules and rate schedules is, of course, unaltered.

Estimating in Times of Extreme Pressure.—This condition is the converse of that just discussed. If the plant is working at its full normal schedule, and an opportunity comes to bid on a contract which would require a long period of overtime, or double- or treble-shift working, it will be obvious that normal process rates no longer apply, as they are representative of ordinary normal conditions.

Revision of service-factor schedules and of process rates is, therefore, indicated in order to establish new process rates which may be applied to the new estimate.

Two opposite effects, as explained in former chapters, are brought about by extension of working hours to a new standard. Annual charges are thinned out. Hourly charges increase proportionately to the new hours. In revising a schedule for overtime or double-shift working, the annual charges remain without alteration. Such items as are hourly, including all indirect (service) labor and some of the indirect material, will have to be recalculated for the extended hours. The schedules

are then totaled and new process rates calculated from the revised figures These new process rates will apply during the continuance the overtime or double-shift working

Intermittent expenditure may also be affected For example, night work, or overtime in winter months, may necessitate an increased allowance for lighting and, perhaps, heating Repairs and maintenance charges may also be revised upward If double- or treble-shift working is in question, the depreciation situation should also be reviewed, and if judged necessary, higher rates applied to cover the extra wear and tear on equipment

Revision of schedules for times of extreme pressure is, therefore, a more complex matter than a revision for hard-times conditions But, when it is done, we should have the satisfaction of knowing that bids for business are not mere shots in the dark which it is hoped will be profitable under the new conditions With schedules and rates revised as described, estimated costs should be very exactly reproduced when the work is eventually passed through the shops

Estimating by Index Numbers or Ratios —A much less satisfactory method of revising former costs to allow current estimates is that of using ratios between the average former costs of process rates, direct material and direct labor and the average present cost If, at a previous date, process rates in a department aggregated $5,000 and, today, they aggregate $5,500,[1] a ratio of 100 110 is established If then, on a given job, former process cost was $200, present-day process cost will be $220 Similarly,[1] if former direct wages aggregated $6,000 and are now $7,200, the ratio is 100 120, and a job which took $400 direct wages will now take $480 This is a quick, though not very sure, method of making revisions of costs for new estimates, and, as it depends on averages (which are always dangerous), it should not be employed except in cases of great urgency and involving no large amounts The same method can, of course, be applied to recalculating cost of direct material It is hardly necessary to point out that if processes have been changed in any way since the last occasion, the method is not satisfactory It cannot be used to cover conditions of extreme pressure or hard times

[1] Assuming the same number of working hours in the month

CHAPTER XLIV

SOME SPECIAL PROBLEMS CONCLUSION

It would require several volumes to deal adequately with all of the interesting points arising out of costing problems While it is hoped that in the present work a firm outline of the service-factor and process-rate method of costing has been established, a great many details have necessarily been ignored A few of the more important of these will be briefly glanced at in this chapter, which concludes the treatment of factory costs

Class Burden—There is one variety of expenditure that cannot be charged into service factors and process rates, but must (where it exists) be separately applied In an engineering business, for example, if a technical department is maintained the work of which is wholly devoted to one product out of several, it is evident that the cost of this department must not be allowed to pass into costs generally but must be confined to increasing the cost of the only product concerned This variety of expenditure is termed *class burden* to distinguish it from normal overhead which finds its way into service factors

If the special product is manufactured entirely by a separate range of processes, then it would not be difficult to apply the expenditure to process cost by means of a special-service factor distributable among those processes Usually, however, such special product is turned out by aid of the ordinary processes The question then arises How are we to get this special or class burden charged correctly into costs?

One of the chief difficulties to be contended with is the vague relation that will probably exist between the cost of the special service and the quantity of the special product manufactured If the former were $5,000 a year and the factory cost of product were always in the neighborhood of $250,000, then we could say that such cost must be increased by 2 per cent to cover the service in question But with varying output this cannot be done

A similar problem arises when auxiliary equipment,[1] such as expensive dies, cutters, molds, etc, are used for one kind of product alone It is easy to calculate the annual charges on such equipment but difficult to establish a relation between this annual cost and the actual quantity produced

Solution of the problem lies along the lines of establishing an arbitrary relation, based as far as possible on observed facts, between annual cost and expected maximum output of the special product If the ratio thus set up fails to distribute all of the expenditure, a balance may be carried forward and a higher rate instituted in the next financial period

Bonus Payments—The modern plan of offering a bonus, usually departmental, for a certain maximum production (which is equivalent to offering a reward for 100 per cent of standard) based on quality or quantity or both, introduces another variable into costs Though this payment is really an increase in direct wages, it may also be regarded as overhead in the sense that it is expenditure not connected with any particular job It cannot, however, be included in service cost of any kind, because it is not a regular recurrent expenditure but varies from month to month It could be standardized but not very satisfactorily The only feasible plan appears to be to establish a ratio between the total direct wages of the department for the month and the total bonus payable, and then increase direct wages by this ratio Thus, if wages are $5,000 and $100 bonus is earned, an increase of 2 per cent is applicable to all jobs worked on

Sometimes the bonus is paid to all indirect workers as well as to direct labor This complicates the matter, as it is then impossible to exclude this variable from service expenditure An attempt must then be made to standardize the amount on the basis of a year's bonus earnings, keeping a separate account for the item and watching closely to observe that actual bonus does not get away too far from standard or budgeted bonus

Spoilage and Waste—In some classes of business the items of spoilage and waste are inseparable accompaniments of productive processes That is, for so much output so much waste and spoilage may be expected [2]

[1] See the author's "Manufacturing Costs and Accounts," 2d ed , 1929, pp 108, 237, 435, for a fuller discussion of this question

[2] See also "Manufacturing Costs and Accounts," 2d, ed , 1929, pp 98–107, for full discussion of spoilage, waste, scrap and by-products

We must here distinguish between *normal* and *excessive* waste or spoilage The former should be reduced to an annual value and included in a special-service factor Obviously, its distribution to processes will be highly individual It will not do to distribute it evenly among production centers The excess above this amount can be regarded as illegitimate and, therefore, simply as waste, which is chargeable to profit and loss like any other item of waste

The Occasionally Used Machine—Another vexed problem not met with in the majority of industries but not uncommon in some, particularly of the engineering type, is that of the machine which is not used and is not expected to be used more than, say, 50 per cent of the standard working hours Closely allied is the problem of special equipment which may be wholly idle at certain times and very busy at others, according as orders obtainable for the product dictate The making of heavy armor plate and other military and naval supplies are industries of this character

The difficulty lies in ascertaining what may be considered as a standard working year for equipment of this kind It is evident that the factor charges will have to be charged during the actual working hours, whatever these may be Space factor, for example, is chargeable against the machine, since its non-use does not diminish the cost of the space it is occupying Service factor charges will be much the same whether the machine operates 2,000 or 1,000 hr a year,[1] but, obviously, their incidence per hour, that is, the process rate, depends upon the number of hours the machine is employed, as standard

No working rule can be given for cases of this kind The fixing of standard working hours must be a matter of judgment in each individual case, checked, of course, by a close scrutiny to observe that actual distribution does not get too far from budgeted or expected distribution, owing to the standard having been placed too high or too low When possible, machines and equipment of this kind should be made into a separate department

Processes with Two Process Rates—In heavy engineering industries it may happen that a certain machine, say a powerful lathe, operates on two different products, one of which requires the normal power supply and the other a very much larger supply Under these conditions, it is evident that the power-

[1] Unless the machine occupies a department by itself, in which case there would be no local hourly charges except when working

factor rate for ordinary work will be much too small for the exceptional jobs A second process rate should be set up in this case, which will be the same as the normal rate except in containing a higher power-rate charge

In connection with heavy machinery requiring considerable power, it is highly desirable that such power should be metered, especially if it is, as in the above case, a variable amount When a meter is used, power charges are made to the machine precisely as they are to a commercial consumer of current A separate power-current factor is set up, charges to which will be proportionate to power consumed and credits to which will, also, be proportional to current used on jobs Then each job is chargeable with its own consumption of current

Naturally, this extra factor is unnecessary unless in the case of processes using really heavy current, but under such circumstances the control over current consumption will usually pay for the extra trouble and time involved

Machines may also have two process rates when some costly auxiliary attachment is used on some jobs and not on others This is a part of the problem of auxiliary equipment, and this solution is not often applicable Sometimes, however, conditions will be such that it can be applied with advantage

Standardization of Selling Expense—Selling expense is much less amenable to standardization than is manufacturing capacity The chief reason for this is that while manufacturing operations are relatively stable and recurrent, sales are liable to vary within wide limits from causes wholly beyond the control of the manufacturer Local occurrences and local competition may adversely affect certain sales districts, even though total sales may keep up, by reason of greater activity in other markets The contrary of this may also occur

In a staple business fluctuations may be slower and less significant, but in specialty lines they are frequently so large as to preclude useful standardization Changes of fashion, the pressure of alternative products, poor trade, all converge to create fluctuations, though they be countered by extending the field of selling operations Though under such circumstances the total sales of one year may equal those of another, they may have been effected by a very different proportion of activities Hence, under these circumstances, standardization of what may

be termed "selling factors"—advertising, printed matter, traveling expense, packing, freights, etc.—is hardly worth while.

Classification of Selling Expense.—This, however, does not preclude the division of product into classes, and the allocation to these classes of just such classes of expenditure as have been concerned in their marketing. Product A, for example, may require no advertising but a large expense for traveling men. Product B may be sold largely by advertising in trade papers and handled through jobbers. Product C may be sold by consignments made to foreign agents, and so on.

This, it will be observed, is very similar to the way in which one process takes a high space factor and a low power factor, while with another process the reverse may happen. If we regard the selling of each class of goods as a separate process, with orders as the product, then the factors entering into the process will often be quite unequal, some taking more advertising and less traveling, others less advertising and more traveling, and so on. Thus, short of actual standardization, a business selling more than one product may classify its selling expenses as selling factors and discriminate between classes of goods in respect to the application of these factors.

In making up selling prices, therefore, an *average* selling price, such as is obtained by the procedure represented by Fig. 103*b*, may be quite different from that of any particular class of product if there is more than one. The $130,000 output with its $6,500 selling expense gives an average of 5 per cent. But this may actually be subdivided between two classes of product, thus:

	Selling Expense	Output	Per Cent
Product A	$4,950	$110,000	4½
Product B	1,550	20,000	7¾
	$6,500	$130,000	

Thus, the cost of selling product B is considerably higher than that of product A.

Relation of Selling to Manufacturing.—The principal relation between selling and manufacturing is the maintenance of a steady stream of production by means of a constant supply of orders. Manufacturing being a series of recurrent activities, the most efficient conditions are set up when the flow of product through the shops is uniform and even. *Slackness of production*

means waste whether this slackness is brought about by careless factory management or by a failure of orders. By means of the service-factor and process-rate method of costing, the amount of this waste can be ascertained in dollars. If due to failure of orders, the amount of *extra* effort to get business which is justifiable can be also evaluated. If, for example, it is found that owing to lack of orders, $1,000 a month is being wasted, then, obviously, if we can bring about full time by spending $500 more than normal in an effort to get business, this loss will be reduced to $500. More than this, the working force and all services will be held together and the disorganization due to reductions avoided. In other words, really more than $500 will be saved if full time is maintained, although this is not directly measurable.

Where more than one product is being manufactured, and if each is made by several processes in common but also by certain processes peculiar to each line, it is important to keep the proportion of business in each line steady, since an overplus in one line and a deficiency in another will lead to a disturbance of smooth running, some processes being overworked and others idle.

Conclusion.—Further consideration of sales and selling is outside the scope of this work. Manufacturing and selling are wholly different kinds of activity. They meet only at the point just mentioned, namely, in the necessity to maintain uniformity in the flow of orders. The whole question of an expanding business is also necessarily left out of account. As regards the factory, a time of expansion will be one in which conditions are changing with some rapidity. Frequent recalculation of schedules will, therefore, be necessary, but this will be less if new departments are being added than when existing departments are being enlarged. Enlargement of a department necessarily disturbs all values concerned from service factors to process rates. As regards selling, a time of expansion may or may not give rise to lower selling expense. The only thing that can be said here about such a situation is that expansion sets up such changing conditions that extra vigilance should be exercised in regard to costs, selling expenses and prices, so as to maintain the various elements of the whole organization in the relative positions which experience has shown to be those of relative efficiency. The influence of expansion should not be allowed to lead to unbalanced developments.

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